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WM. WHARTON, JR., & CO.
INCORPORATED

PHILADELPHIA, PA.
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Rails and Special Track Work

Main Office, Twenty-fifth Street and Washington Avenue

Philadelphia, Pa., U. S. A.

Catalogue No. 10

1903

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Street Railway Switch Works: Twenty-fifth Street and Washington Avenue, Philadelphia, Pa.

Steam Railroad Switch Works: Jenkintown, Pa.

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Page Index

	Page
Preface	11
Street railway special track work	13
Integral work. Definition	14
Manganese steel. Properties of	15
Integral construction, for tongue switch, mate and frog, girder rail	16, 17
Manganese steel center construction, for tongue switch, mate and frog, girder rail	18, 19
Long radius tongue switch, Carver patent	20, 21
Protected heel tongue switch, Nichols patent	22, 23
Unbroken main line construction, for switch, mate and frog	24, 25
Unbroken main line construction, description and illustrations	26, 27
Bolted manganese steel construction, for tongue switch, mate and frog, tee rail	28, 29
Standard manganese steel construction, for tongue switch, mate and frog, tee rail	30, 31
Plain bolted construction, for tongue switch, mate and frog, tee rail	32, 33
Integral construction, for crossing, girder rail	34, 35
Manganese steel center construction, for crossing, girder rail	36, 37
Split switch	38, 39
Split spring switch and mate, for turnouts	40, 41
Spring rail frogs	42, 43
Draw-bridge funnel castings	44
Frog with different rail sections, with manganese steel center	45
Cast-welded compromise joints and combination rails	45
Tongue pivot bearing	46, 47
Spring box for tongue switch	46, 47
Portable crossover	48
Crossings, street railway over steam railroad	49
Two-rail type	50
Three-rail type	51
Three-rail type, with corner plates	52
Three-rail type, without corner plates, P. R. R. standard	53
Three-rail type, with continuous plates, New England standard	54, 55
Three-rail type, with long corner plates, P. & R. Ry. standard	56, 57
With manganese steel rails on steam railroad track, Nichols patent	58, 59
With manganese steel centers	60, 61
Derailing switch	62
Layouts of special track work for street railways	63
Fitting up and laying out special track work	64
Photographic reproduction of a working plan	65
Track layout at Dewey Square, Boston, Mass., U. S. A.	67
Campello car-house layout, Brockton, Mass, U. S. A.	68
Car-house layout, Hoboken, New Jersey, U. S. A.	69
Track layout for St. James and McGill Streets, Montreal, Canada	70
Track layout at Calzada de Chapultepec and Calle de Bucareli, Mexico City, Mexico	71
Track layout at Avenida Don Carlos and Calçada do Marquez d'Abrantes, Lisbon, Portugal	72
Car-barn layout for Perth Electric Tramways, Ltd., Perth, Western Australia	73
Complicated crossings for Tenth Street and Philadelphia & Reading Railway, Philadelphia, Pa., U. S. A.	74
Special track work for cable railways and electric railways with underground conduit	75
General remarks	76
Conduit track layout at Sixth Avenue and Twenty-third Street, New York City, U. S. A.	77
Conduit crossings at Eighth and G Streets, S. E., Washington, D. C., U. S. A.	78
Conduit crossover for Anacostia & Potomac River Railroad Co., Washington, D. C., U. S. A.	79
Conduit crossings on King Street, for N. S. W. Government Tramways, Sydney, Australia	80
Transfer tables and turntables for street railways	81
General remarks	82
Flush floor transfer table, with incline approaches	83
Turntable	84

132101

	Page
Industrial and shop railways, trucks and turntables for same	85
General remarks	86
Truck with solid wrought-iron frame	87
Plate turntable	87
Rim turntable	88
Standard wrought-iron frame truck	89
Extra long truck, with gridiron top	90
Truck, with wooden top	91
Pig-iron truck	92
Steam railroad special track work	93
Wharton improved railroad switch, main line unbroken	94, 95
Wharton improved railroad switch, main line unbroken	96, 97
Wharton throw-off or derailer	98, 99
Stiff split switch	100
Spring split switch	100, 101
Split switch, four tie bar pattern	102
Split switch, three tie bar pattern, with reinforcement straps	102, 103
Combination split switch for wide and narrow gauges	104
Three-throw split switch	105
Stub switch	106
Tongue switch and mate	107
Riveted plate frog	108, 109
Filled and bolted frog, P. & R. Ry. standard	108, 109
Spring rail frog for light traffic	110, 111
Spring rail frog with slide plates and reinforced wing rail	110, 111
Vaughan's patent sliding wing frog	112, 113
Vaughan's patent hinged spring frog	112, 113
Manganese steel frogs	114, 115
Manganese steel center construction, for tongue switch, mate and frog	116, 117
Guard rail clamp	118, 119
Guard rails for frogs, with clamps or braces	118
Ground throw with forged steel lever	120, 121
Combination ground throw and low target	120, 121
Low target stand for yard use	122
Switch stands	122, 123
Crossings, two-rail type	124, 125
Crossings, three-rail type	126, 127
Manganese steel crossing	128, 129
Slip crossings with movable point frogs	130
Rails	131
General remarks	132
Girder rail sections	133–141
High tee rail sections, for street railways	142
Slot rail sections	143
Engineering data for street railways	145
Special track layouts, general remarks	146
Diagrams of typical track layouts	147–154
Standard crossovers, with tongue switches	155
Standard lateral turnouts, with tongue switches	156
Standard equilateral turnouts, with tongue switches	157
Standard lateral turnouts, with split switches	158
Standard equilateral turnouts, with split switches	159
Standard switch pieces, general remarks	160
Dimensions of standard switches and mates	161, 162
Dimensions of standard frogs	163
Dimensions of standard unbroken main line switch and frog pieces	164
Weights of standard switches, mates and frogs	165
Spiral curves	166–174
Decimal equivalents of vulgar fractions	175
Lengths of circular arcs for the radius 1	176, 177
Determination of widths of grooves of rails	179

Alphabetical Index

	Page
Banners, for target stands	122, 123
Bearing, adjustable, for tongue pivot	16–21, 46, 47
Bolted and filled frog, for steam railroads	108, 109
Bolted manganese steel construction, for tee-rail tongue switches, mates and frogs, for street railways	28, 29
Bolted manganese steel frog, tee rail, for steam railroads	114, 115
Bolted mate, tee rail, for street railway turnouts	40, 41
Bolted plain construction, tee rail, for street railways	32, 33
Bolted tongue switch and mate, tee rail, for steam railroads	107
Braces, cast iron or malleable iron	118
Cable conduit special track work, for street railways	80
Carver patent long radius tongue switch, for street railways	20, 21
Cast steel construction, solid, for tee rail track, for street railways	30, 31
Cast-welded compromise joints	45
Clamps for guard rails, for steam railroads	118, 119
Clamps for tee rail crossings	54–57
Clips for split switches	100–103
Combination split switch	104
Combination rails	45
Complete layouts of special track work, for street railways	63–80
Compromise joints, cast-welded, for street railways	45
Conduit special track work, for electric street railways	75–80
Crossings:	
Integral crossing, for street railways	34, 35
Manganese steel center crossing, for street railways	36, 37
Manganese steel center crossing, for street railways over steam railroads	60, 61
Manganese steel crossing, for steam railroads	128, 129
Manganese steel rail crossing, for street railways over steam railroads, Nichols patent	58, 59
New England standard crossing, for street railways over steam railroads	54, 55
Nichols crossing, for street railways over steam railroads, with manganese steel rail	58, 59
Pennsylvania railroad standard crossing, for street railways over steam railroads	51–53
Philadelphia & Reading railroad standard crossing, for street railways over steam railroads	56, 57
Scissor crossing of manganese steel bolted frogs, for steam railroads	115
Slip crossings	130
Steam over steam railroad crossings	124–127
Manganese steel crossing	128, 129
Two-rail type	124, 125
Three-rail type	126, 127
Street railway over steam railroad crossings	49–61
Two-rail type	50
Three-rail type	51–57
With corner plates	52, 56, 57
With continuous plates, New England standard	54, 55
Without corner plates	51, 53
With manganese steel center	60, 61
With manganese steel rails, Nichols patent	58, 59
Crossover, portable, for street railways	48
Crossovers, standard lines, for street railways	155
Decimal equivalents of vulgar fractions	175
Derailing switch, for steam railroads	98, 99
Derailing switch, for street railways, girder rail work	62
Diagrams of typical track layouts, for street railways	146–154
Dimensions of standard crossovers, for street railways	155
Dimensions of standard switches, mates and frogs, for street railways	160–164
Dimensions of standard turnouts, for street railways	156–159
Draw-bridge funnel castings, for street railways	44
Easement curves, for street railways	166–174
Electric conduit special track work, for street railways	76–79
Emergency crossovers, portable, for street railways	48
Emergency crossovers, unbroken main line, for street railways,	24–27, 155, 164
Engineering data	145–177
Filled and bolted frog, for steam railroads	108, 109
Fillers, for tee rail crossings	50, 125
Fitting up and laying out special track work	64

	Page
Flanges of wheels	178
Flush floor transfer table	83
Frogs:	
Bolted frog, tee rail, for steam railroads	108, 109
Bolted manganese steel frog, for steam railroads	114, 115
Bolted manganese steel frog, tee rail, for street railways	28, 29
Double spring rail frog, for both steam and street cars	42
Filled and bolted frog, for steam railroads	108, 109
Frog with different rail sections	45
Integral frog, girder rail, for street railways	16, 17
Manganese steel center frog, girder rail, for steam railroads	116, 117
Manganese steel center frogs, girder rail, for street railway over steam railroad in paved streets	60, 61
Manganese steel center frog, girder rail, for street railways	18, 19
Manganese steel center frogs, bolted, for steam railroads	114, 115
Movable point frogs, for steam railroads	130
Plain bolted frog, tee rail, for street railways	32, 33
Riveted plate frog, for steam railroads	108, 109
Solid cast steel frog, tee rail, for street railways	30, 31
Solid manganese steel frog, tee rail, for street railways	30, 31
Spring rail frog, double, for street railways	42, 43
Spring rail frogs, for steam railroads	110–113
Spring rail frog, single, for street railways	42, 43
Standard cast steel frog, tee rail, for street railways	30, 31
Standard frog dimensions, girder rail work, for street railways	163, 164
Standard manganese steel frog, tee rail, for street railways	30, 31
Unbroken main line frog, girder rail, for street railways	24–27
Vaughan's patent hinged spring frog, for steam railroads	112, 113
Vaughan's patent sliding wing frog, for steam railroads	112, 113
Funnel castings for draw-bridge street railway tracks	44
Girder rail sections	133–141
Grooves of rails, widths of	179
Ground throws, for steam railroads or street railways	120, 121
Guard rail clamp, for steam railroads	118, 119
Guard rails, for steam railroad frogs	118
Industrial and shop railways, trucks and turntables for same	85–92
Integral construction, for tongue switches, mates and frogs, for street railways	16, 17
Integral crossing, for street railways	34, 35
Integral work, definition of	14
Knees, for crossings	50, 125
Lamps, for target stands	122, 123
Latch, for unbroken main line tongue switch	24, 26
Layout and fitting up special track work	64
Layouts of special track work, for street railways	63–80
Lengths of circular arcs for the radius 1	176, 177
Long radius tongue switch, for street railways, Carver patent	20, 21
Malleable iron braces for rails	118
Manganese steel construction:	
Bolted, for tee rail crossing, for steam railroads	128, 129
Bolted, for tee rail frogs, for steam railroads	114, 115
Bolted, for tee rail work, for street railways	28, 29
For crossing, with manganese steel centers, for street railway over steam railroads	60, 61
For crossing, with manganese steel centers, for street railways,	36, 37
For crossing, with manganese steel rails, for street railways over steam railroads, Nichols patent	58, 59
For tongue switches, mates and frogs, with manganese steel centers, for steam railroads	116, 117
For tongue switches, mates and frogs, with manganese steel centers, for street railways	18, 19
Standard, for tee rail work, for street railways	30, 31
Manganese steel, properties of	15
Manganese steel rail crossing, street railways over steam railroads, Nichols patent	58, 59
Manganese steel tongues	16–19, 28–31
Manganese steel tongue beds	18–23
Mates:	
Bolted manganese steel mate, tee rail, for street railways	28, 29
Bolted mate, tee rail, for steam railroads	107
Bolted mate, tee rail, for street railway turnouts	40, 41
Integral mate, girder rail, for street railways	16, 17
Manganese steel center mate, girder rail, for steam railroads	116, 117
Manganese steel center mate, girder rail, for street railways	18, 19
Plain bolted mate, tee rail, for street railways	32, 33
Solid cast steel mate, tee rail, for street railways	30, 31
Solid manganese steel mate, tee rail, for street railways	30, 31
Standard cast steel mate, tee rail, for street railways	30, 31
Standard manganese steel mate, tee rail, for street railways	30, 31

	Page
Standard mates, dimensions of, girder rail work	160–162, 164
Unbroken main line mate, girder rail, for street railways	24–27
Movable point frogs, for steam railroads	130
Nichols patent protected heel tongue switch, for street railways	22, 23
Photographic views of track layouts	63–80
Plain bolted construction, for tee rail switches, mates and frogs, for street railways	32, 33
Plates, under crossings, tee rail work	52–57
Portable crossover, for street railways	48
Pratt's patent planed guard rail, for steam railroad and street railway crossings	50–57
Protected heel tongue switch, for street railways, Nichols patent	22, 23
Rail sections, for street railways	131–143
Reinforcement straps for split switches and spring frogs	102, 103, 110
Riveted plate frog, for steam railroads	108, 109
Rods, for split switches	100–103
Shop and industrial railways, trucks and turntables for same	85–92
Slide plates, for split switches	38, 39, 100, 101
Slip crossings, for steam railroads	130
Slot rail sections	143
Special track work layouts, photographs of	63–80
Spiral curves, for street railways	166–174
Split spring switch and mate, for street railway turnouts	40, 41
Split switches, for steam railroads	100–105
Split switch, for street railways	38, 39
Split switch, for wide and narrow gauges	104
Spring box for tongue switch, for street railways	46, 47
Spring split switches, for steam railroads	100–105
Spring rail frogs, for steam railroads	110–113
Spring rail frogs, single and double, for street railways	42, 43
Spring switches, for street railways (see switches)	21, 31, 38, 39, 40, 41, 46, 47
Standard crossover lines, for street railways	155
Standard switch, mate and frog dimensions, for street railways	160–164
Standard turnout lines, for street railways	156–159
Steam over steam railroad crossings	126–130
Steam railroad special track work	93–130
Stiff split switch, for steam railroads	100
Street railway over steam railroad crossings	49–61
Street railway special track work	13–84
Stub switch, for steam railroads	106
Survey for special track work, for street railways	146–154

Switches:

Bolted manganese steel tongue switch, tee rail, for street railways	28, 29
Bolted tongue switch, tee rail, for steam railroads	107
Carver's patent long radius tongue switch, for street railways	20, 21
Combination split switch	104
Derailing switch, for steam railroads	98, 99
Derailing switch, girder rail construction, for street railways	62
Integral tongue switch, girder rail, for street railways	16, 17
Long radius tongue switch, girder rail, for street railways, Carver patent	20, 21
Manganese steel center tongue switch, girder rail, for steam railroads	116, 117
Manganese steel center tongue switch, girder rail, for street railways	18, 19
Nichols patent protected heel tongue switch, for street railways	22, 23
Plain bolted tongue switch, tee rail, for street railways	32, 33
Protected heel tongue switch, girder rail, for street railways, Nichols patent	22, 23
Split spring switch, for street railway turnouts	40, 41
Split switches, for steam railroads	100–105
Split switch, for street railways	38, 39
Split switch, for wide and narrow gauges	104
Spring split switches, for steam railroads	100–105
Spring split switch, for street railways	38, 39
Spring tongue switch, for street railways	46, 47
Standard cast steel tongue switch, tee rail, for steel railways	30, 31
Standard manganese steel tongue switch, tee rail, for street railways	30, 31
Standard switch dimensions, girder rail work	160–162, 164
Stiff split switch, for steam railroads	100
Stub switch, for steam railroads	106
Three-throw split switch, for steam railroads	105
Throw-off switch, for steam railroads, unbroken main line	98, 99
Throw-off switch, unbroken main line, girder rail work, for street railways	62
Tongue switch, bolted, for steam railroads	107
Unbroken main line switch, for steam railroads	94–97

	Page
Unbroken main line tongue switch, for street railways	24–27
Wharton improved railroad switch, main line unbroken, for steam railroads	94–97
Target stands, for steam railroads and street railways	122, 123
Tee rail sections, for street railways	142
Three-throw split switch, for steam railroads	105
Throw-off switch, unbroken main line, for steam railroads	98, 99
Throw-off switch, unbroken main line, girder rail work, for street railways	62
Tightening tongue pivot bearing	46, 47
Tongue beds of manganese steel	18, 19, 22, 23
Tongues, forged steel	32, 33
Tongues, manganese steel	16–31
Tongue pivot bearing	46, 47
Tongue switch and mate, bolted tee rail, for steam railroads	107
Transfer tables, for street railways	81–83
Transition curves, for street railways	166–174
Trucks, for industrial railways	86–92
Turnouts, standard lines, for street railways	156–159
Turntables, for industrial railways	86–88
Turntables, for street railways	81, 82, 84
Unbroken main line switch, for steam railroads	94–97
Unbroken main line construction, for tongue switch, mate and frog, for street railways	24–27
Vaughan's patent hinged spring frog, for steam railroads	112, 113
Vaughan's patent sliding wing frog, for steam railroads	112, 113
Weights of standard switches, mates and frogs	165
Widths of grooves of rails	179
Wharton improved railroad switch, main line unbroken, for steam railroads	94–97
Wharton throw-off or derailer, for steam railroads	98, 99
Wheel flanges	178
Working plan, photographic reproduction	65

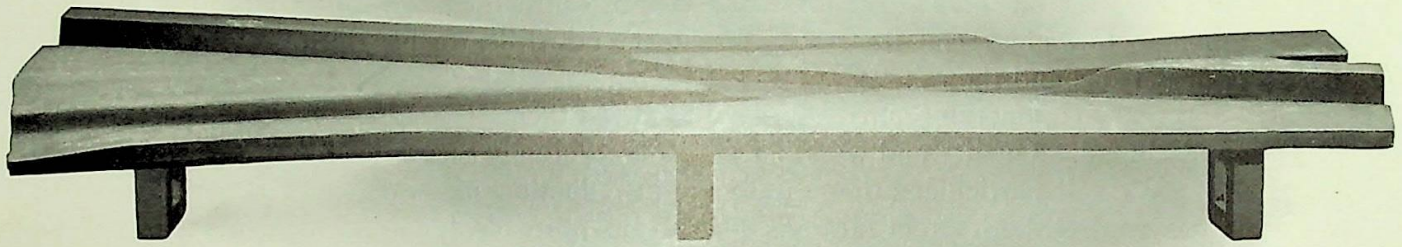
Preface

AFTER more than forty years' experience as manufacturers of street railway special track work, being still under the leadership of Mr. William Wharton, Jr., who established the business in 1859, and having in late years absorbed the business of the former Wharton Railroad Switch Company in the manufacture of special track work for steam railroads, we herewith present to our patrons and the railway public a new general catalogue.

Our manufactures and designs have proved themselves unexcelled at home and abroad. Quality and workmanship are absolutely guaranteed by us.

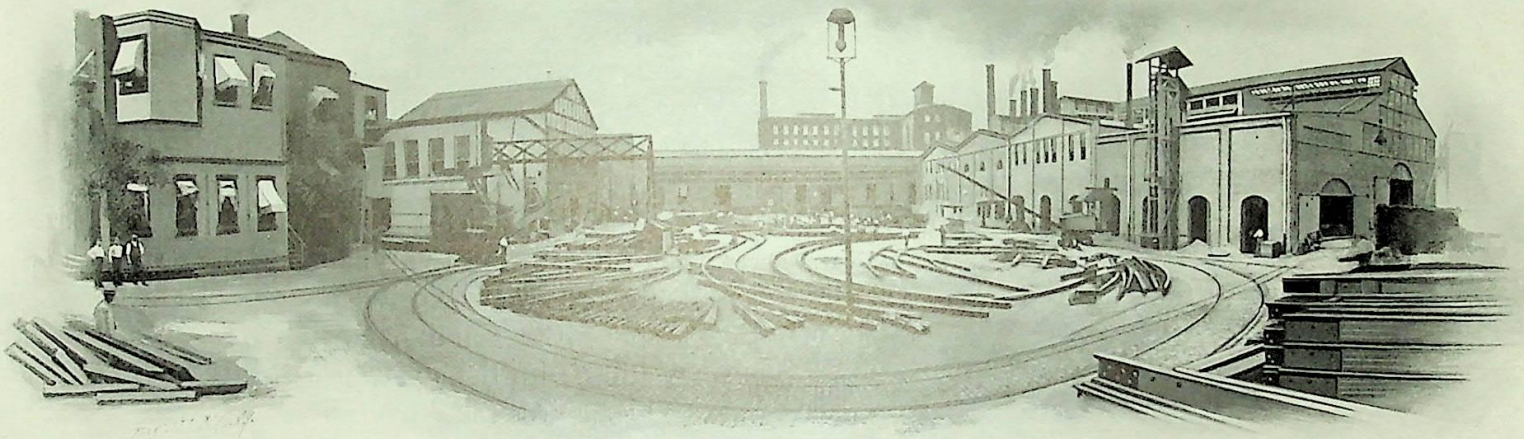
We call particular attention to the introduction of Manganese Steel in track work of both street railways and steam railroads, for which we have the sole right, under special arrangement with the licensees, in the United States.

Philadelphia, Pa., 1903



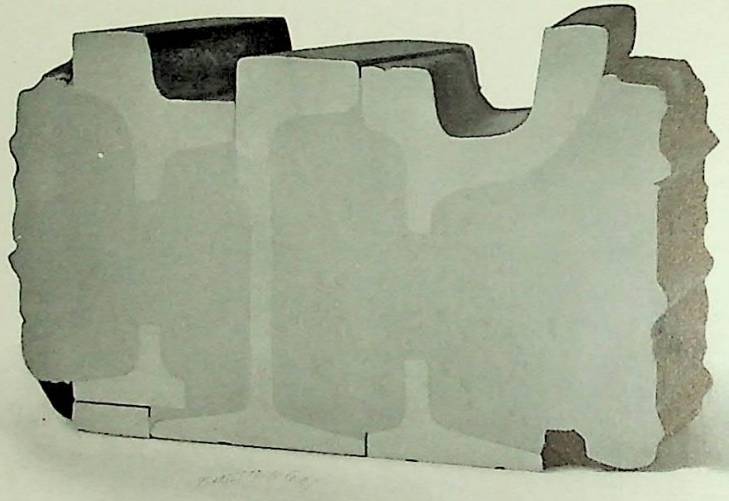
2,570,000 electric cars passed over this frog plate

Street Railway Special Track Work



Street Railway Switch Works, 25th Street and Washington Avenue, Philadelphia, Pa.

What is Integral Work?

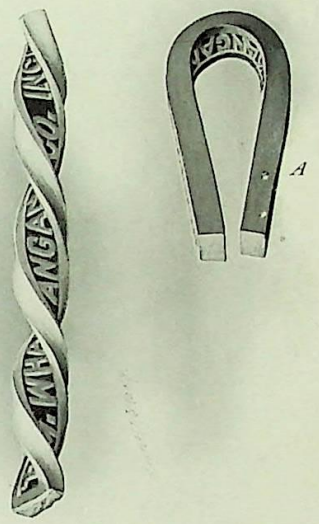


Photograph of Section of Integral Work

THE term "INTEGRAL WORK" was first used by us and registered as a trade-mark in 1891, when, after several years of experimenting, we had succeeded in building frogs, switches, mates and crossings for street railways of girder rails, by uniting them with a solid mass of cast metal run through and around them, discarding the former methods of using bolts and rivets for that purpose. The cast metal actually amalgamating with the steel of the rails made the entire piece a unit, or as we called it "integral." The combination of the solidity, equal to that of a single casting, with the superior wearing qualities of the rolled steel rails over those of steel castings, and the fact of the extending arms of rolled rails admitting of as good a fish-plate connection as anywhere in the track, made the work superior to any then produced by other methods. We make integral work of any height of construction, 6 inches or over.

Straight bar twisted cold

Straight bar bent cold



Mark *A* made by ¼-inch drill in one minute. Same drill under same pressure will make hole one inch deep in steel rail in same time.

What is Manganese Steel?

MANGANESE STEEL is a metal unique in that it combines extreme hardness with great toughness, it being possible to bend double pieces of raw manganese steel castings, which are at the same time so hard that they can scarcely be drilled or cut by any tool. The meaning of this is that not only are its individual particles extremely hard but that they adhere to each other with great tenacity, and this combination is the secret of the superior ability of this metal to resist wear.

We protect the points of greatest wear, in frogs, tongue switches, mates and crossings, by the insertion of manganese steel, so that these pieces will last as long as the adjoining rails, manganese steel being the only metal that will accomplish this.

In girder rail special work we insert plates of manganese steel solidly bedded, using the integral method of uniting the body and the rail arms of the special pieces.

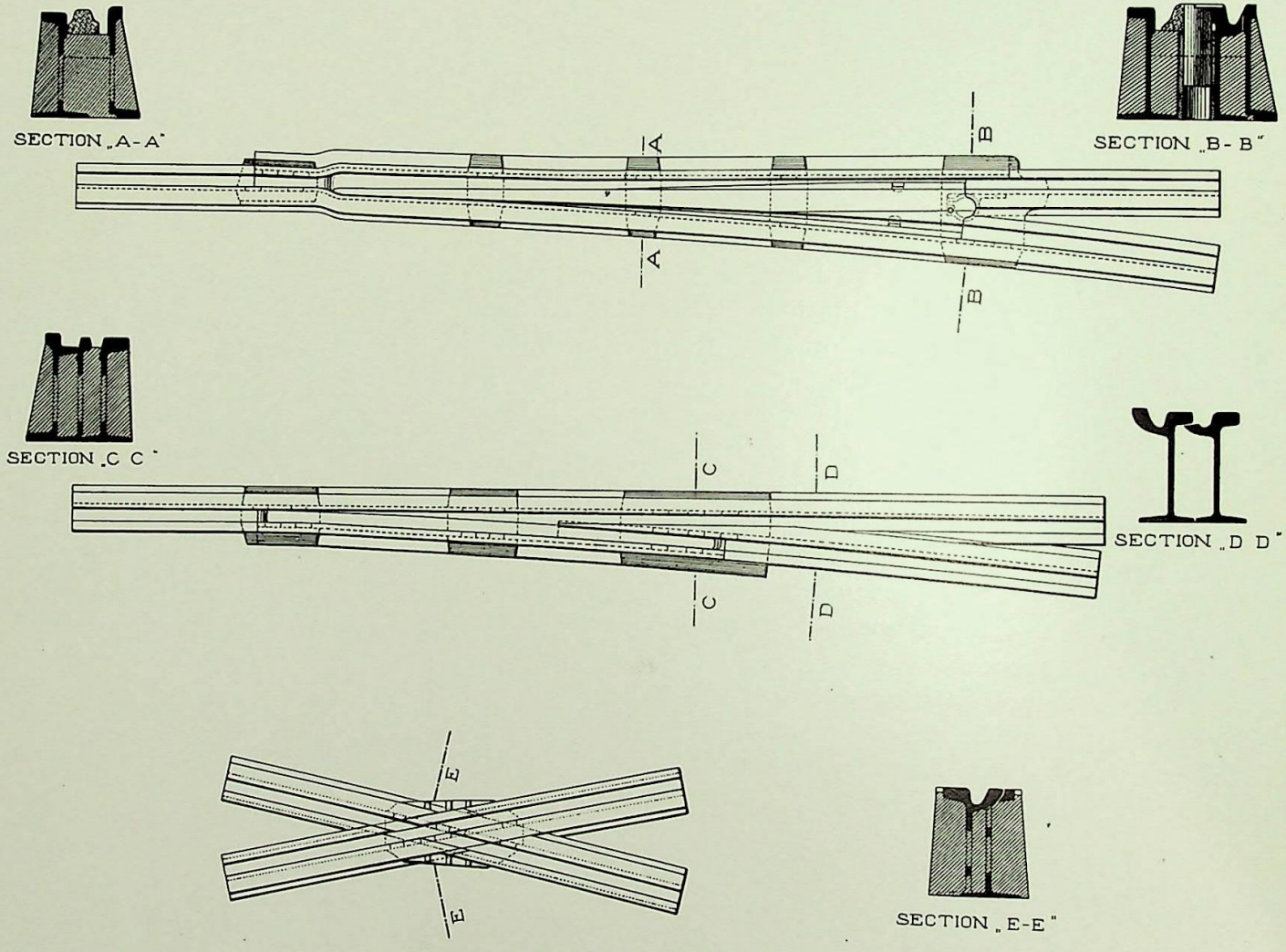
In tee rail work we bolt in the points and reinforcing pieces, or we cast solidly special pieces that are not too large for their successful manufacture out of this metal.

We have the sole right in America for the use of manganese steel in track work.

In the photographic illustrations which follow, the manganese steel parts are shown in light color.

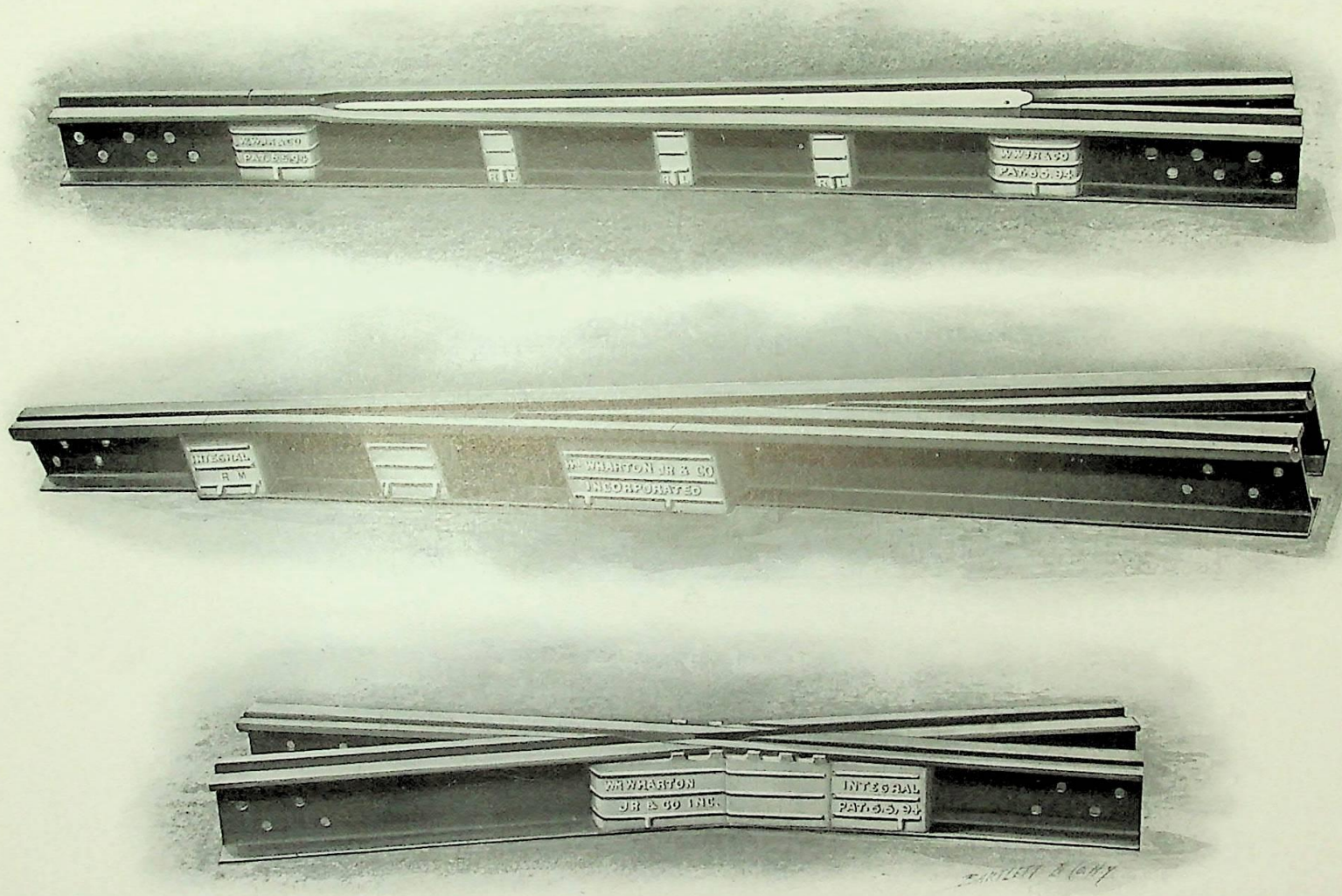
Tongue Switch, Mate and Frog, Integral Construction

Patented June 5, 1894



Tongue Switch, Mate and Frog, Integral Construction

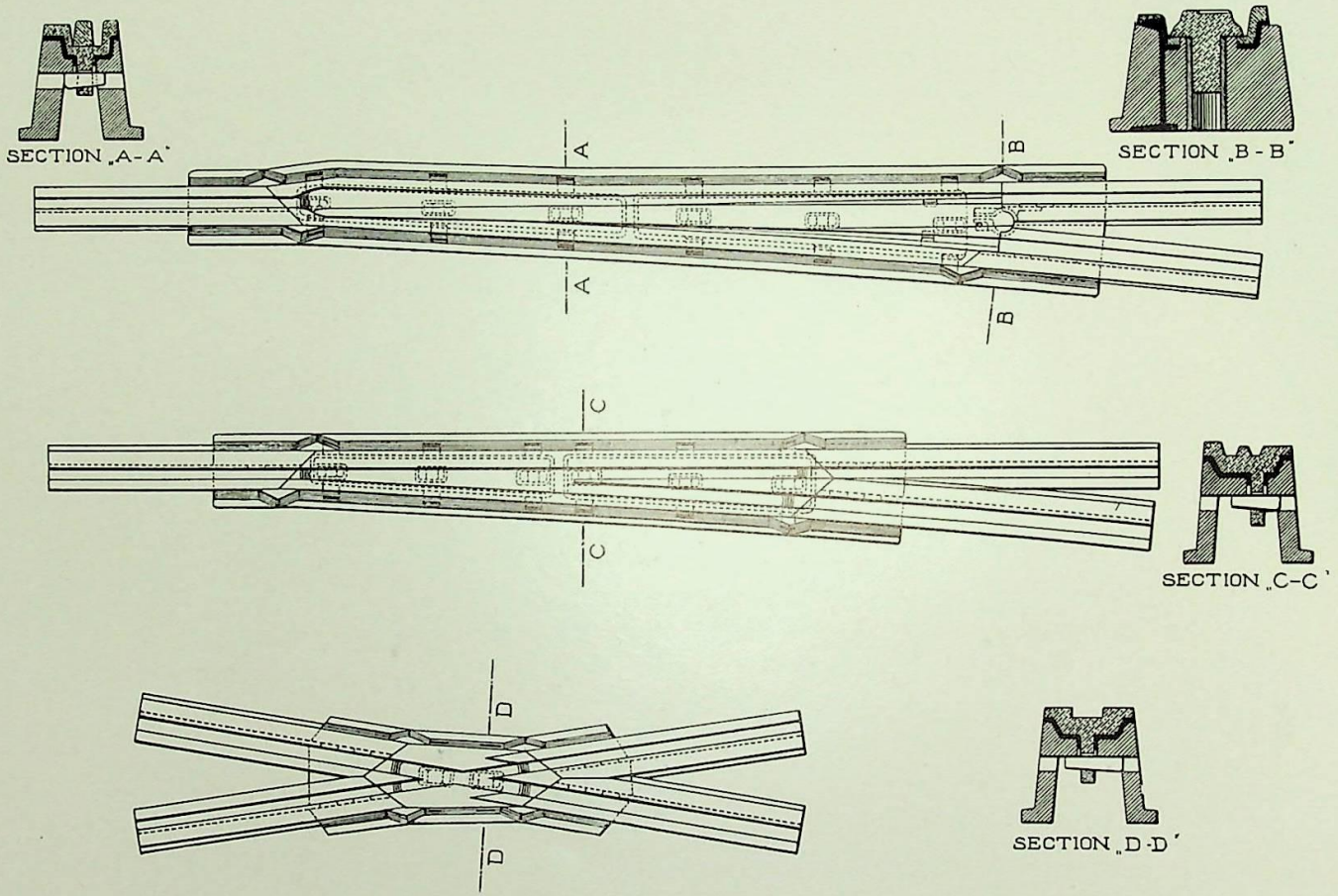
Patented June 5, 1894



All wearing surfaces are rolled steel rail, excepting the maganese steel tongues. Adjustable bearings for tongue pivots.

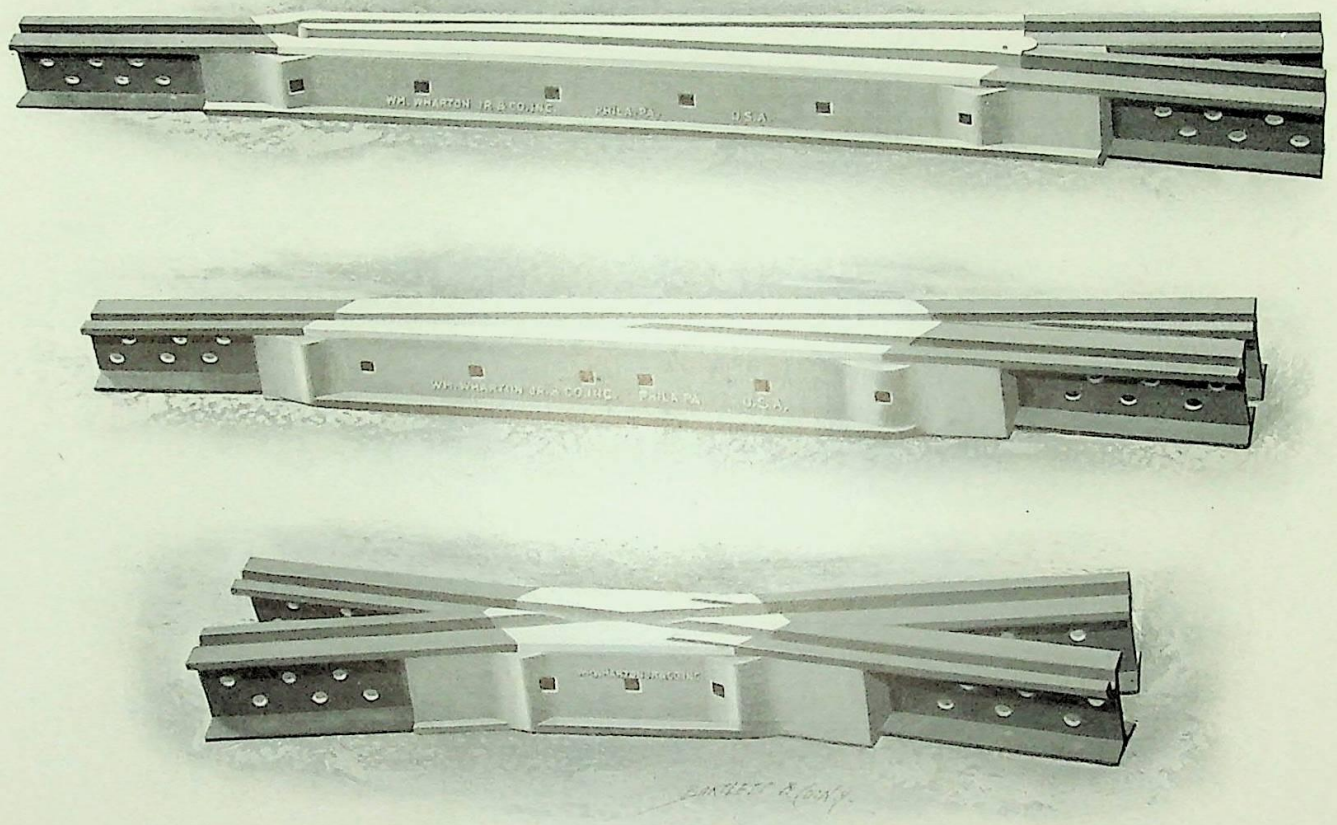
Tongue Switch, Mate and Frog, Manganese Steel Center Construction

Patented May 16, 1893; June 5, 1894; September 3, 1895; December 10, 1895; July 20, 1897; November 2, 1897



Tongue Switch, Mate and Frog, Manganese Steel Center Construction

Patented May 16, 1893; June 5, 1894; September 3, 1895; December 10, 1895; July 20, 1897; November 2, 1897

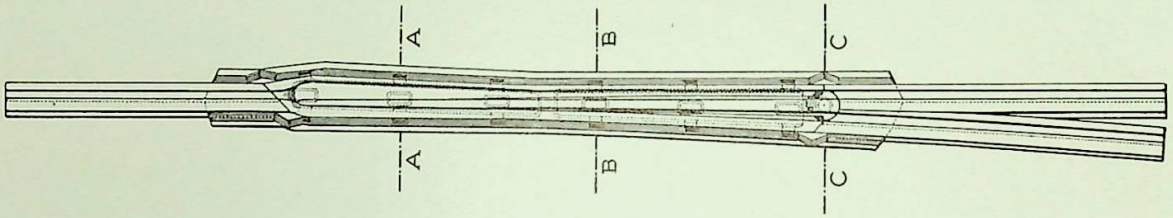


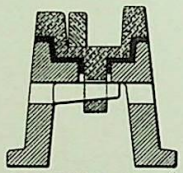
The manganese steel centers outwear the adjoining rails. While renewable in cases of accident or development of hidden defect, experience has proved that these centers very rarely need renewal, as they last until the entire layouts are worn out.

Manganese steel tongues and tongue beds. Adjustable bearings for tongue pivots.

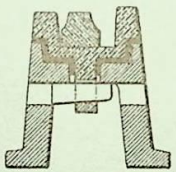
Long Radius Tongue Switch, Maganese Steel Center Construction

Carver Patent, April 23, 1895





SECTION „A-A"



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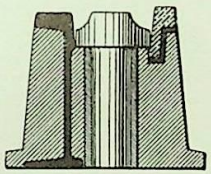
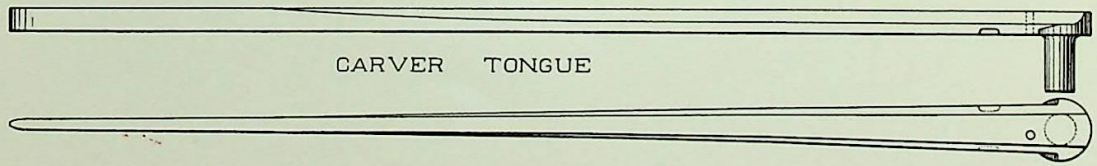


SECTION „C-C"



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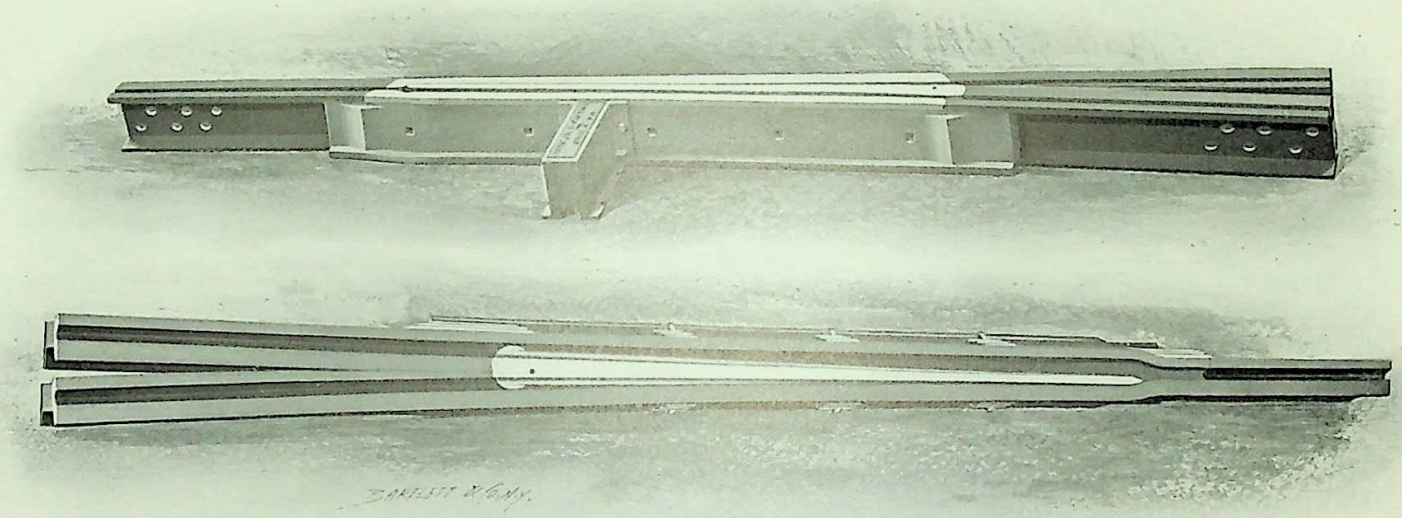
Long Radius Tongue Switch

Carver Patent, April 23, 1895



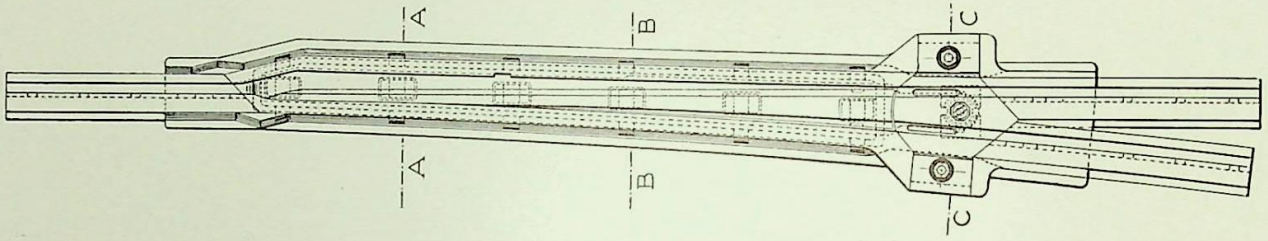
Made to 200 feet radius for lateral switches, and 350 feet radius for equilateral switches. The tongue is stiffened by horizontal extensions towards the sides of the switch below the flangeway, and the heel of the tongue has a circular bearing against the sides, relieving the pivot from side strains. Note the ease of the lines; no danger of the tongue rocking or springing. Tongues can be placed on the outside gauge line of curves with perfect safety, as with the long radius the guard function of the tongue becomes no longer necessary. This avoids the shifting of the tongue while the weight of the car is on it, as in turnouts when the tongue is made self-acting by a spring.

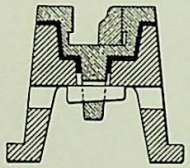
This switch is particularly recommended for turnouts.

132101

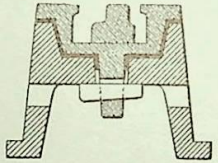
Protected Heel Tongue Switch, Manganese Steel Center Construction

Nichols Patent, May 23, 1899

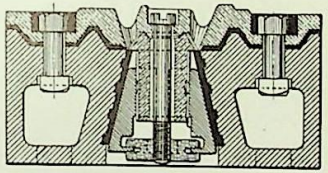




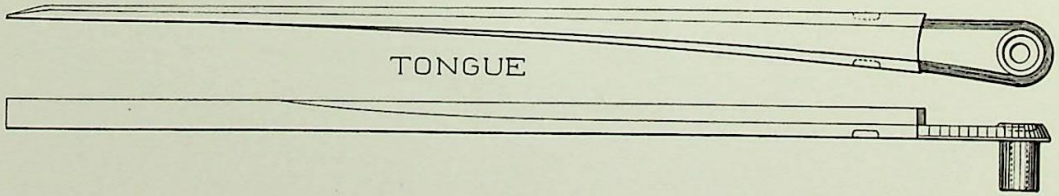
SECTION „A-A"



SECTION „B-B"

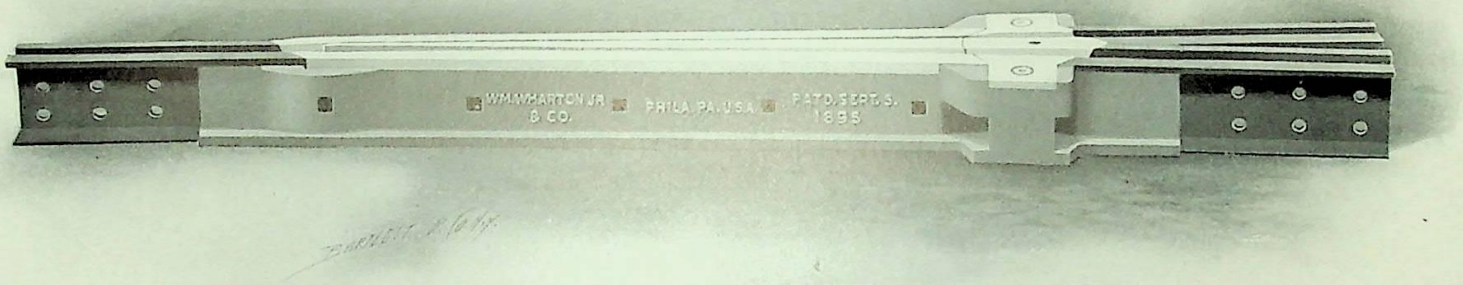


SECTION „C-C"



Protected Heel Tongue Switch, Manganese Steel Center Construction

Nichols Patent, May 23, 1899

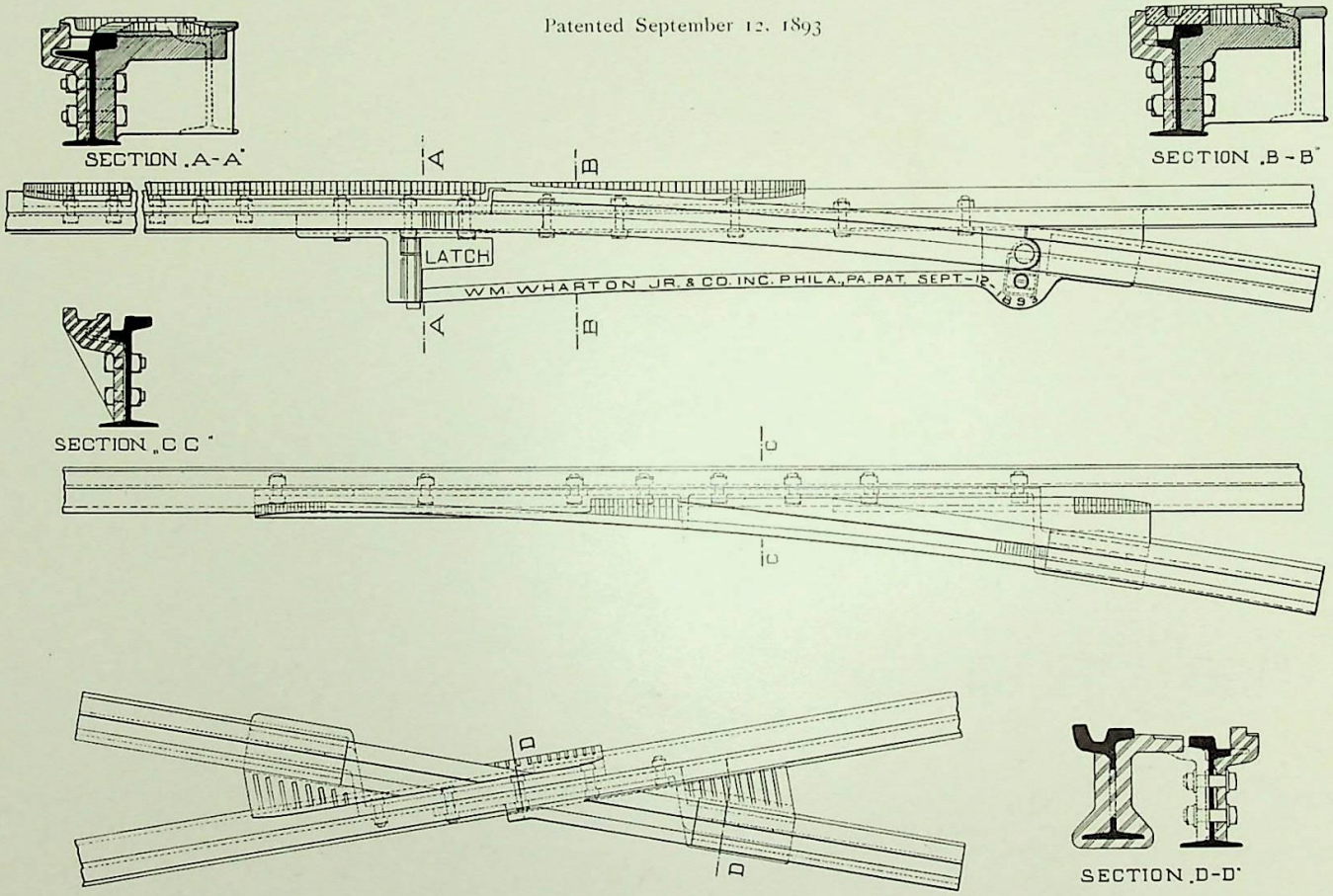


This tongue switch is a new departure. The tongue is stepped off on the heel end, and the reduced part covered by a manganese steel plate, so that the pivot is located underneath that plate and is entirely protected from the blows of the car wheels. The joint between the tongue and the fixed surfaces of the tread and the guard is thrown far ahead of the pivot, so that the accidental throwing of the tongue between trucks by the action of the wheels is practically impossible.

A large number of these switches are in use, and have proved to clear themselves of dirt, ice and snow through several severe winters. Other advantages of this switch are obvious.

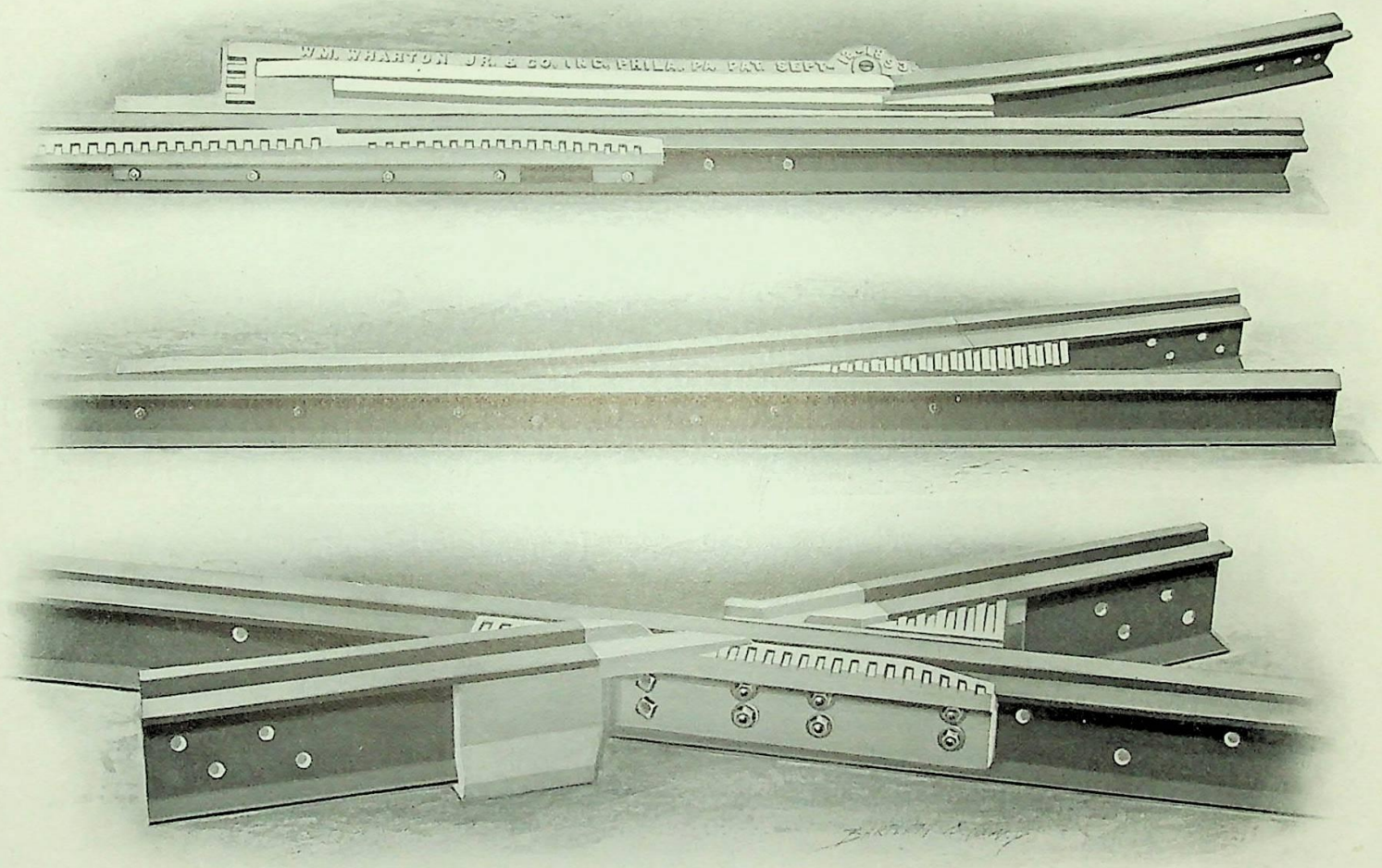
Switch, Mate and Frog, Unbroken Main Line Construction

Patented September 12, 1893



Switch, Mate and Frog, Unbroken Main Line Construction

Patented September 12, 1893



For description see next page

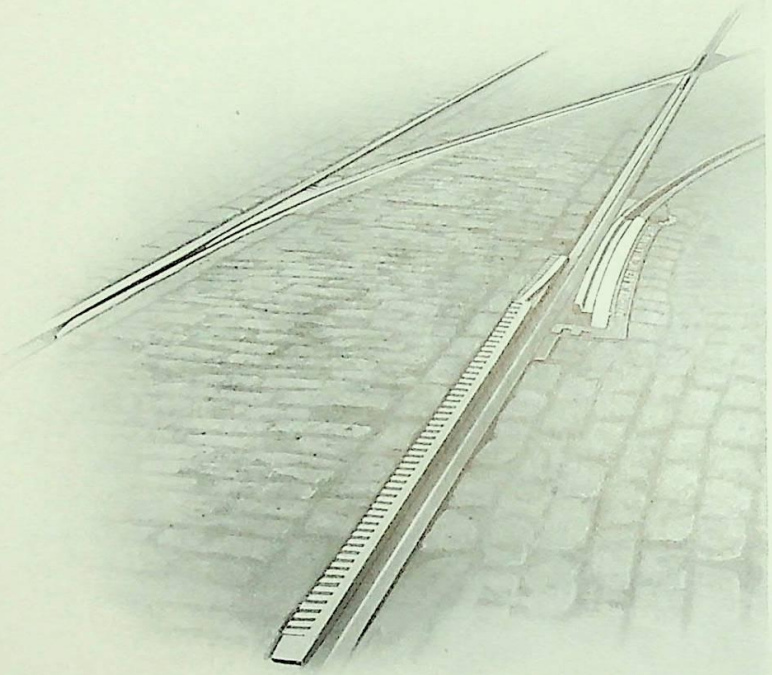
The Wharton Unbroken Main Line Construction for Street Railways

Patented September 12, 1893

WE call particular attention to our Unbroken Main Line Switch, designed and patented by our Mr. Wharton. It is the only switch of its kind that fully meets the requirements. Its extreme simplicity of construction makes this switch sure of action in all kinds of weather. Where a switch is needed, but only occasionally used, it gives most decided advantages. The main track is entirely smooth and unbroken, and when the curve is not used there is no wear and tear on the switch. The switch, the mate and the frog are simply castings made to bolt to the sides of the main rails, which remain undisturbed in the track. The switch is provided with the peculiarly shaped tongue made of manganese steel. When set for the curve its inclined end raises the car wheel over the head of the main rail, and the guard on the tongue deflects and guides the wheel into the curve. We furnish this switch either with or without a latch to secure the tongue in the required position.

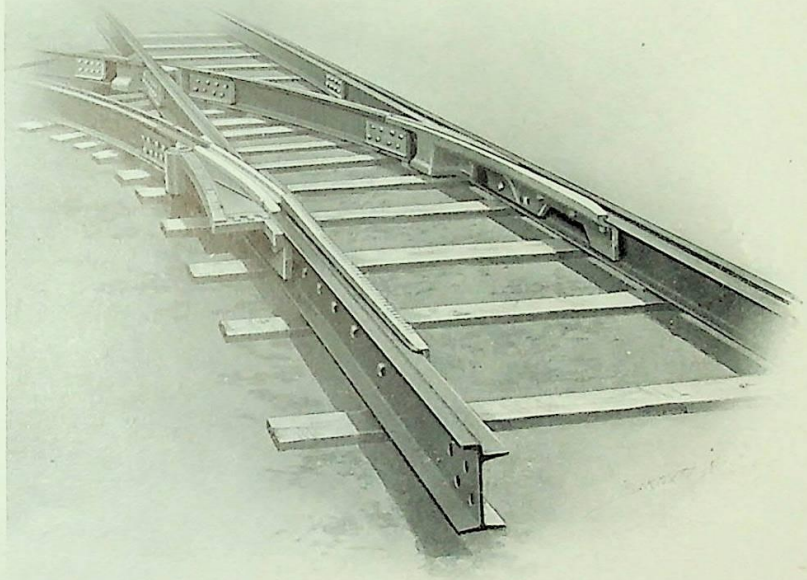
The Wharton Unbroken Main Line Construction

Patented September 12, 1893



In the Street

Tongue thrown for Main Line Open

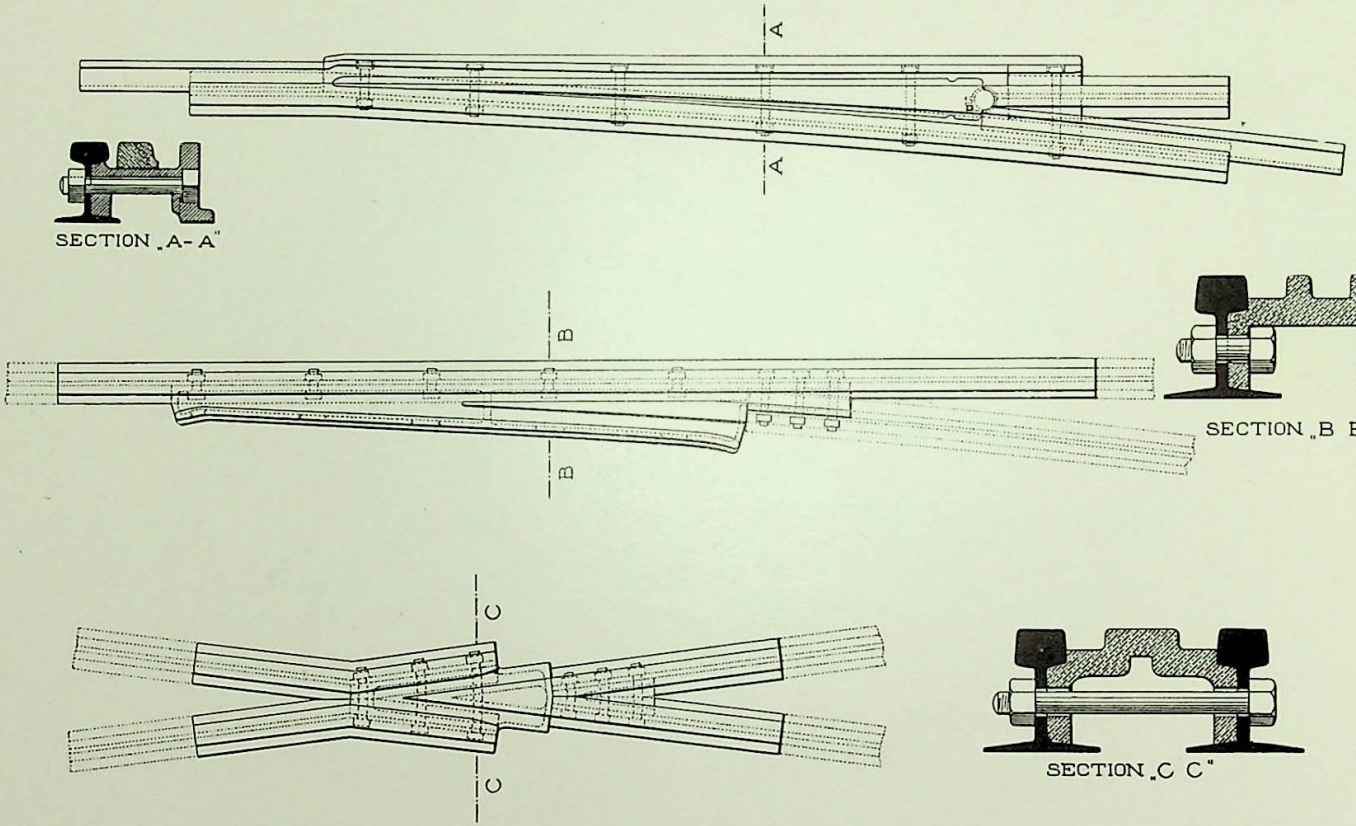


Fitted in the Yard

Tongue thrown for Curve

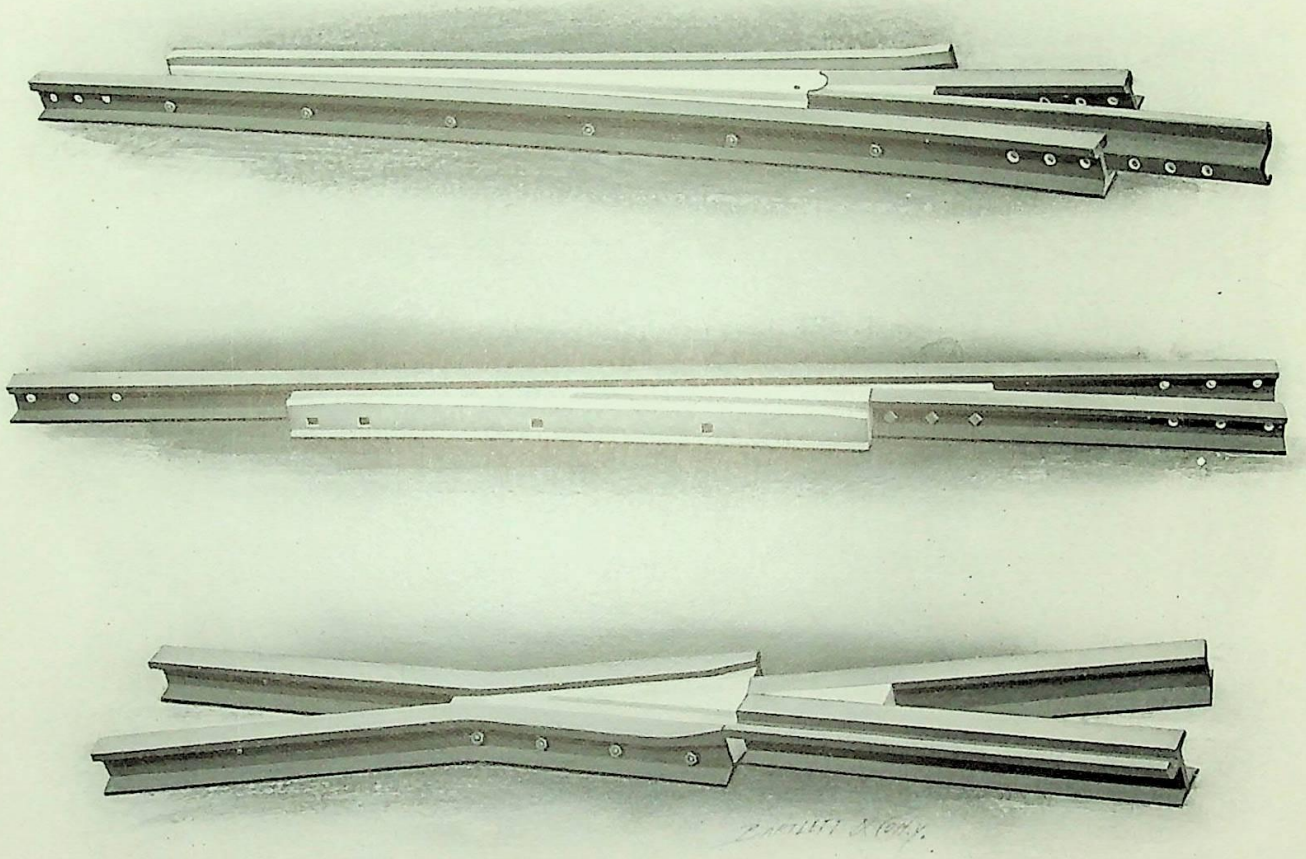
Tongue Switch, Mate and Frog, Bolted Manganese Steel Construction

For Tee-rail Track



Tongue Switch, Mate and Frog, Bolted Manganese Steel Construction

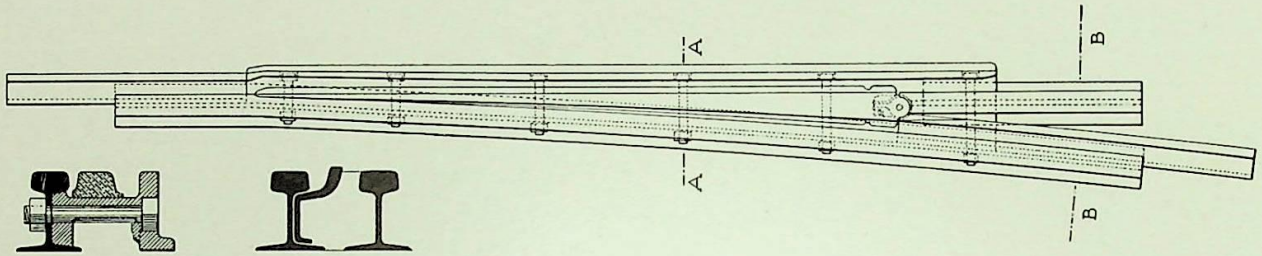
For Tee-rail Track



Manganese steel points will outwear the adjoining rails. Made for all sections of tee rails.

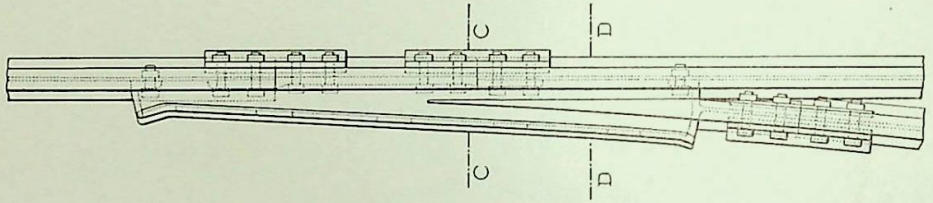
Tongue Switch, Mate and Frog, Standard Manganese Steel Construction

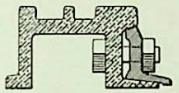
For Tee-rail Track



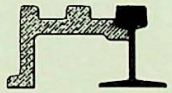
SECTION „A-A"

SECTION „B-B"





SECTION „C-C"



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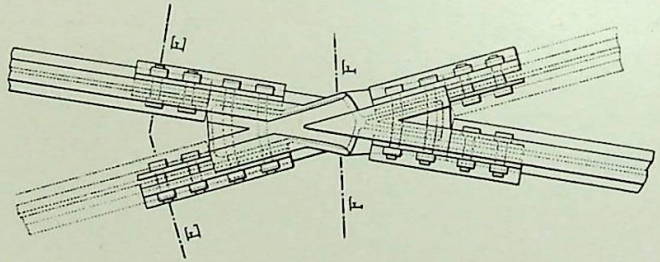

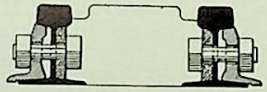

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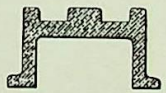
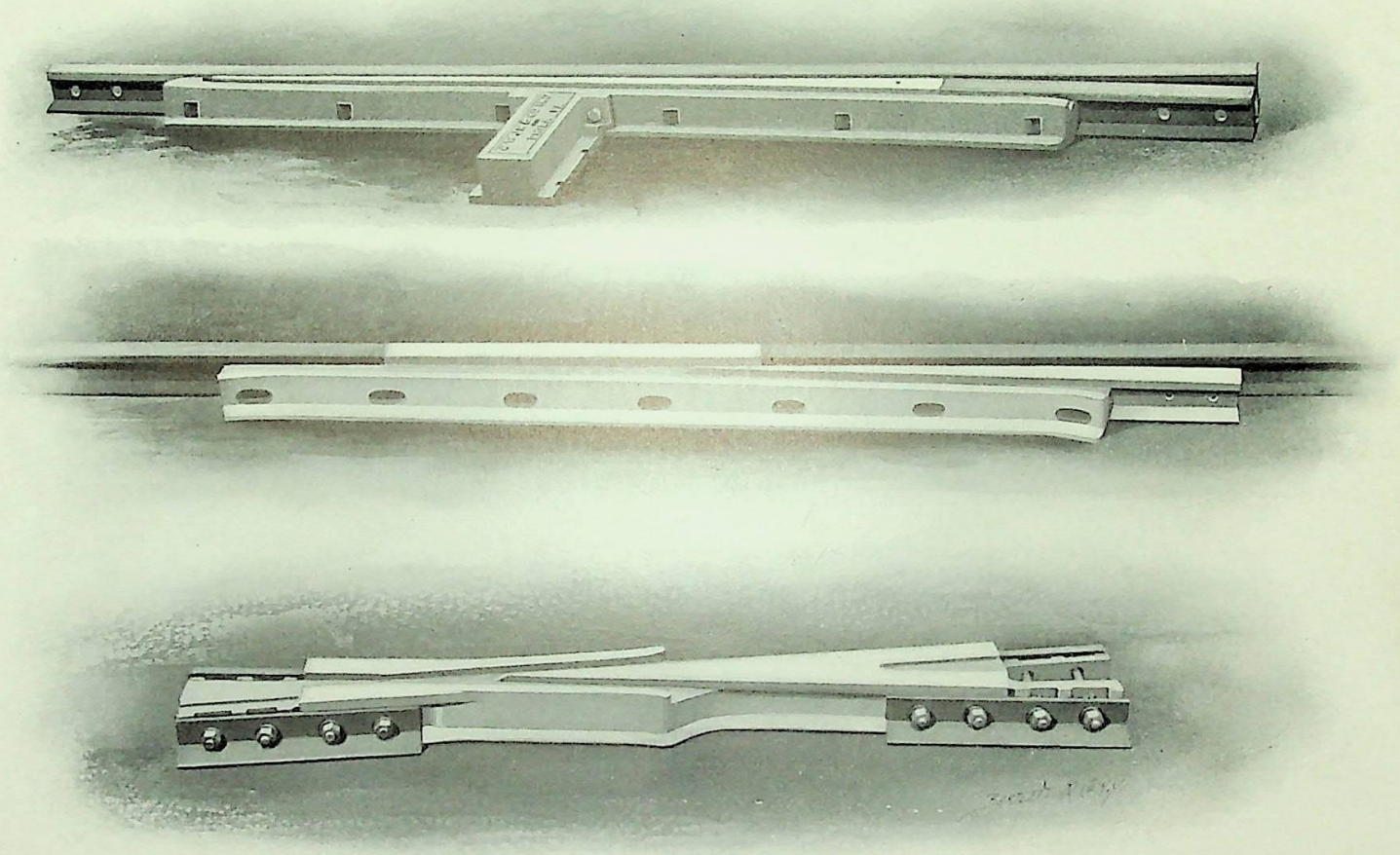


SECTION „F-F"

Tongue Switch, Mate and Frog, Standard Manganese Steel Construction

For Tee-rail Track

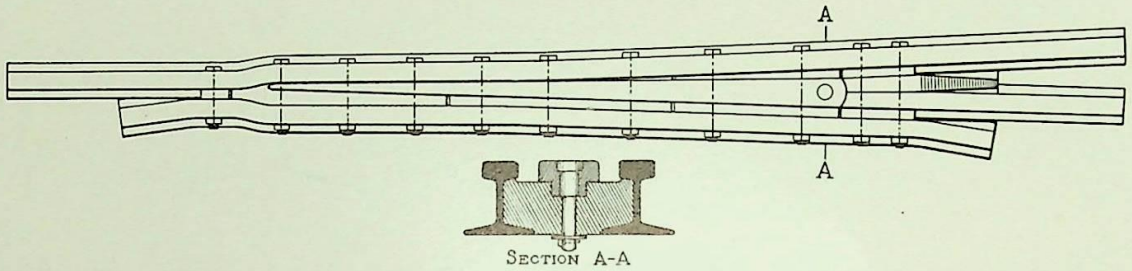


Mate and frog are solid manganese steel castings of this same style made of ordinary cast steel.

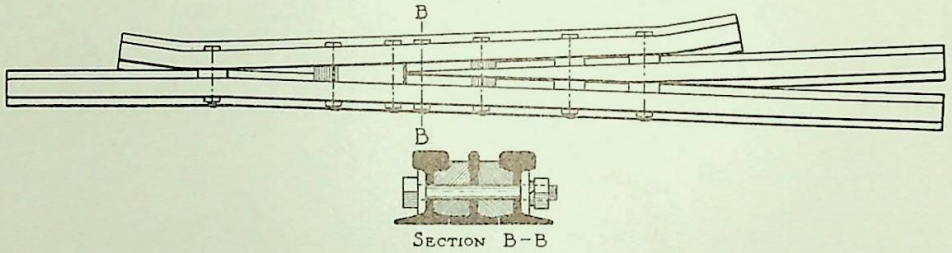
Switch has manganese steel tongue and adjustable bearing for tongue pivot. We also furnish work

Tongue Switch, Mate and Frog, Plain Bolted Construction

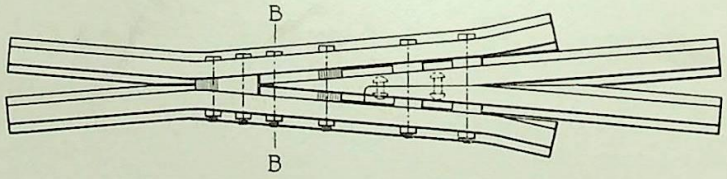
For Tee-rail Track



SECTION A-A

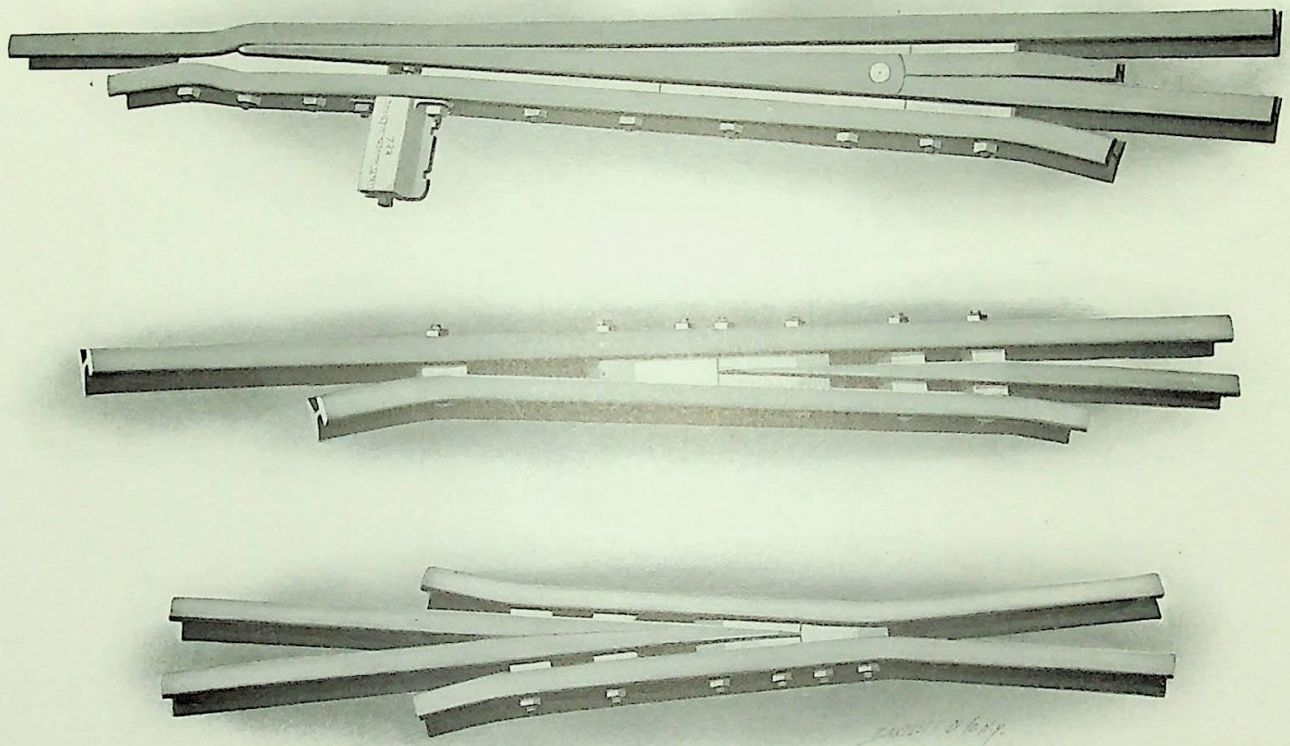


SECTION B-B



Tongue Switch, Mate and Frog, Plain Bolted Construction

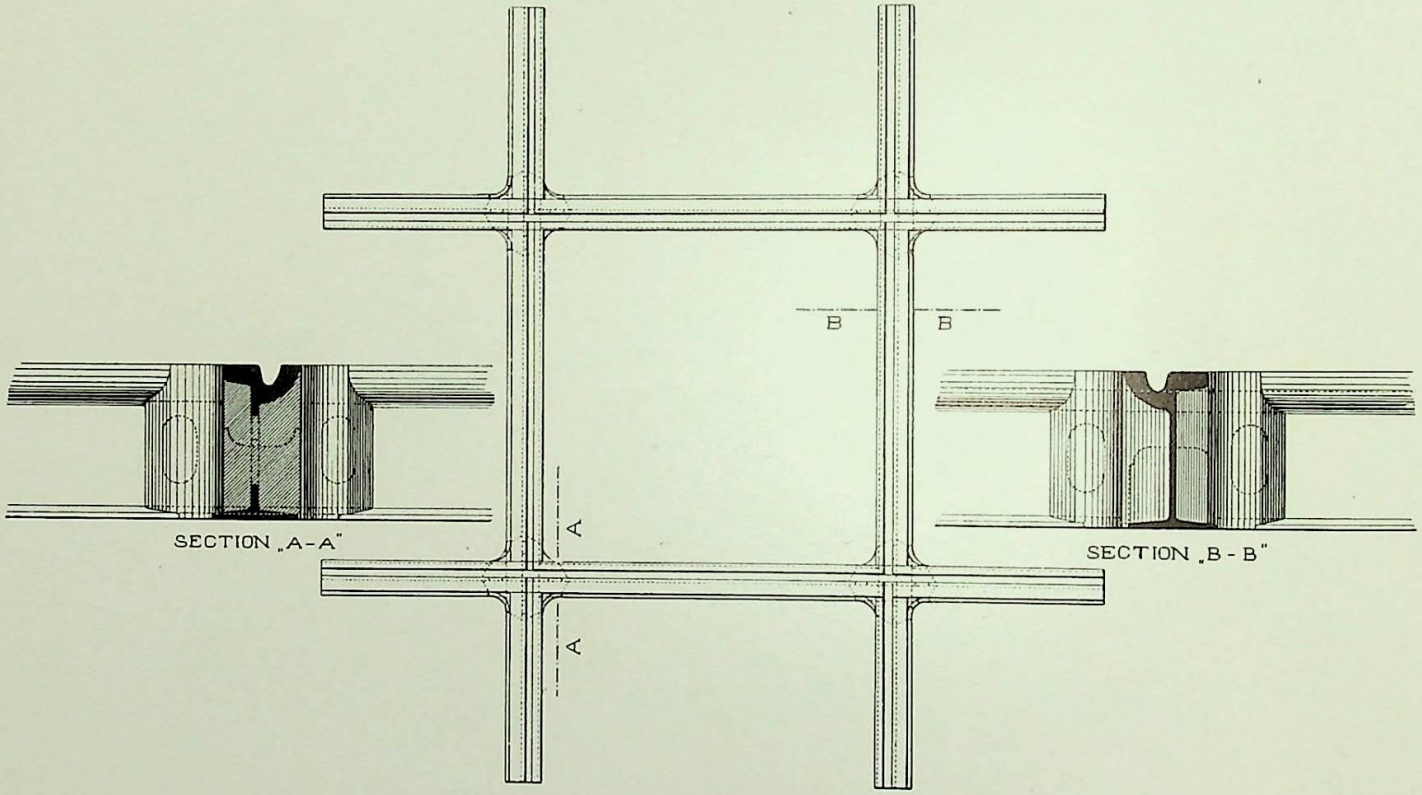
For Tee-rail Track



Forged steel tongue. Raised fillers to carry wheel flanges

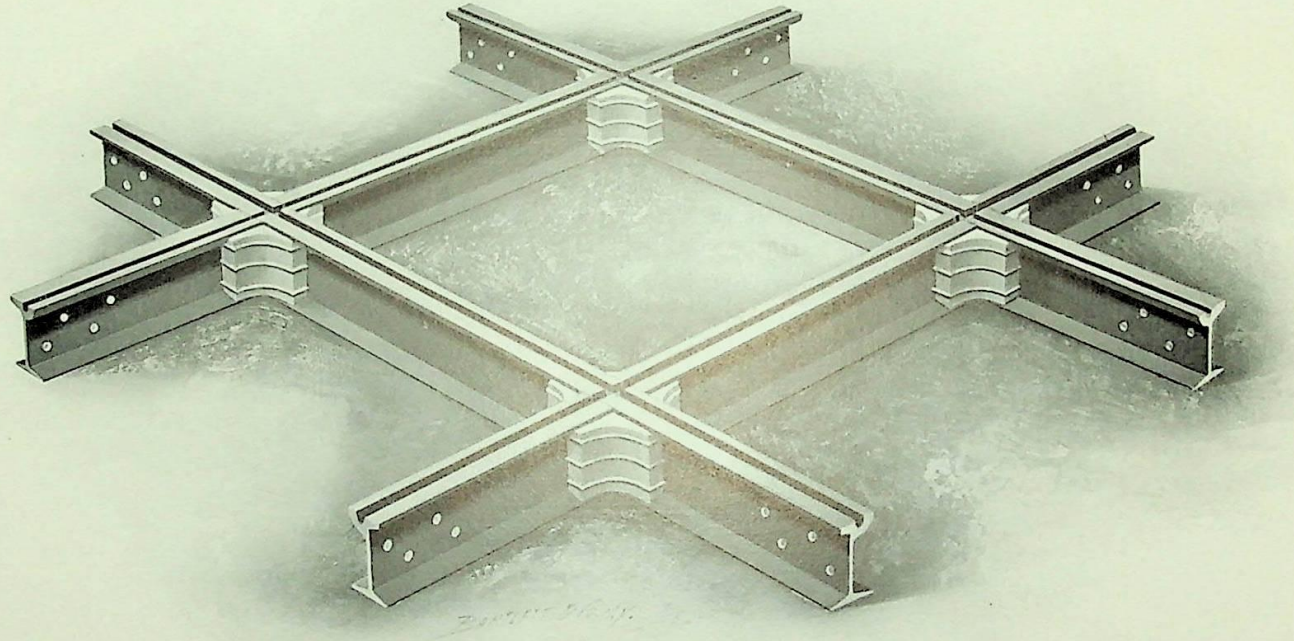
Street Railway Crossing, Integral Construction

Patented June 5, 1894



Street Railway Crossing, Integral Construction

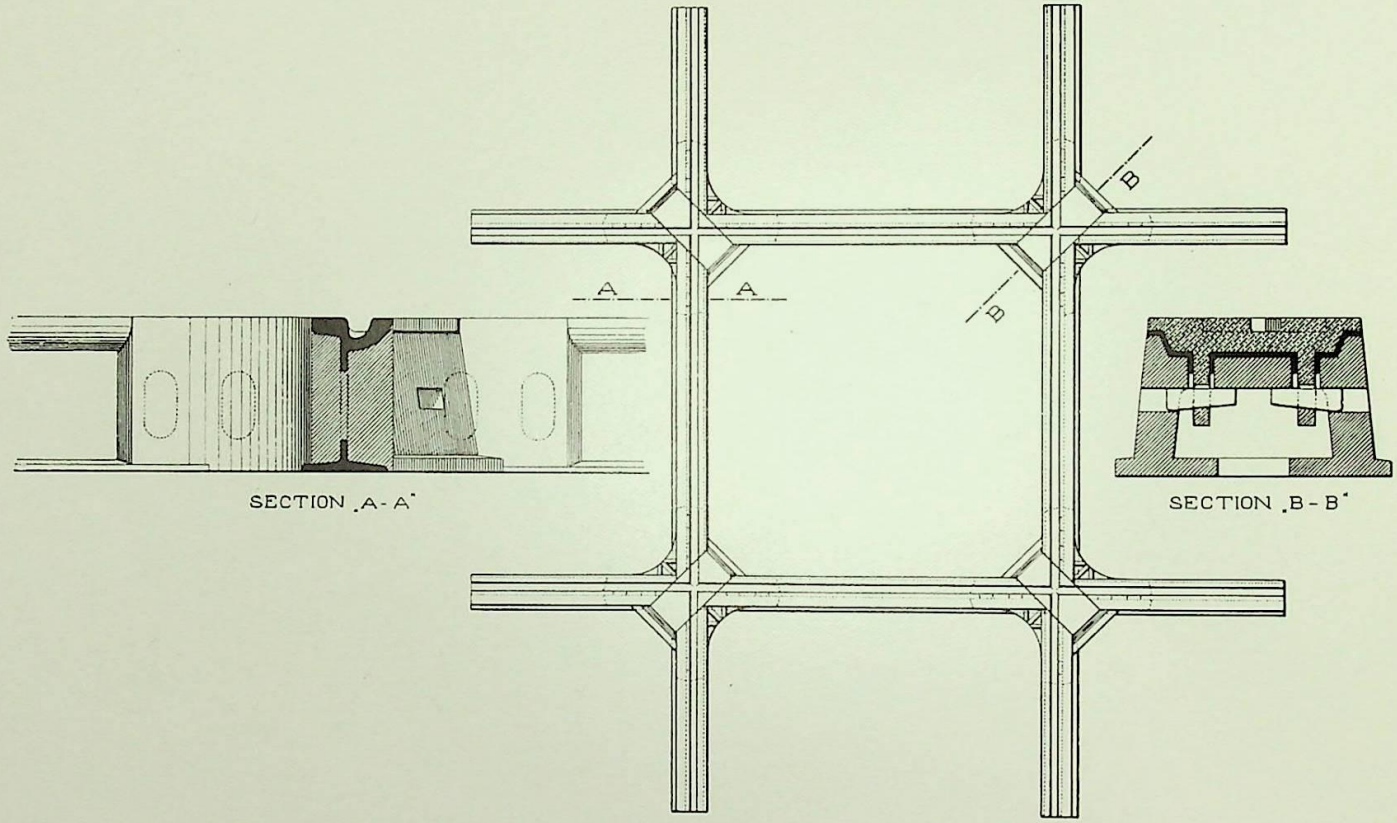
Patented June 5, 1894



All wearing surfaces are rolled steel rail. As solid as a single piece.

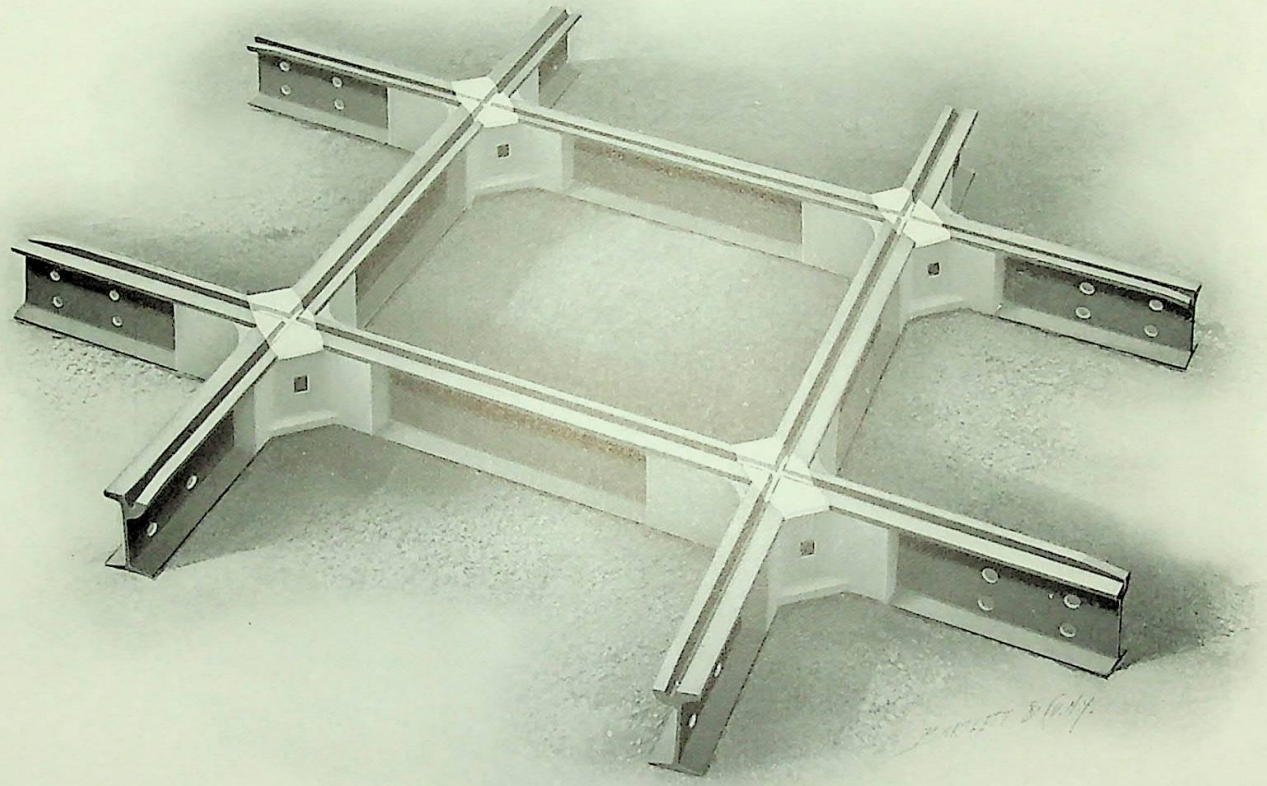
Street Railway Crossing, Manganese Steel Center Construction

Patented May 16, 1893; June 5, 1894; September 3, 1895



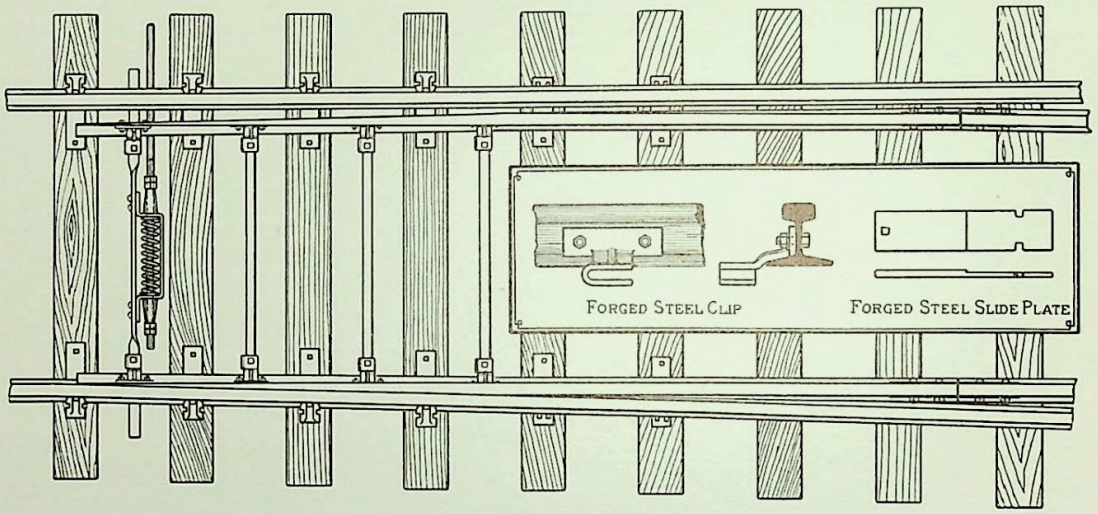
Street Railway Crossing, Manganese Steel Center Construction

Patented May 16, 1893; June 5, 1894; September 3, 1895

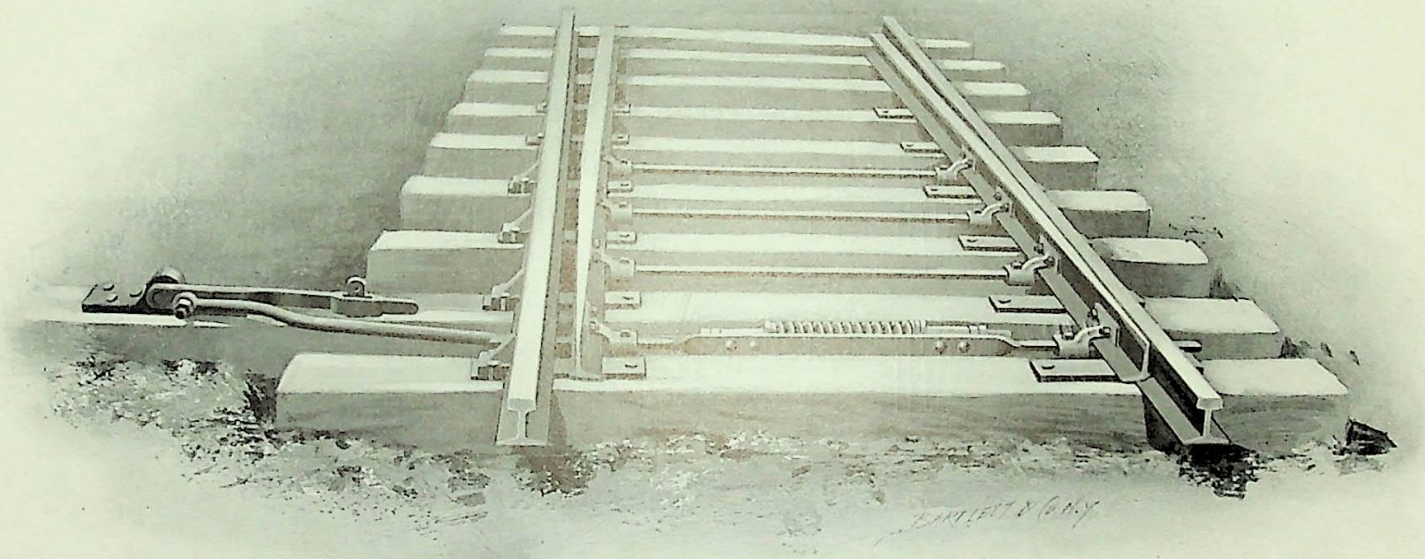


Intersecting points made of manganese steel. Will last as long as the adjoining rails. Where shipping facilities will permit we always make a crossing in one piece.

Split Switch for Street Railways



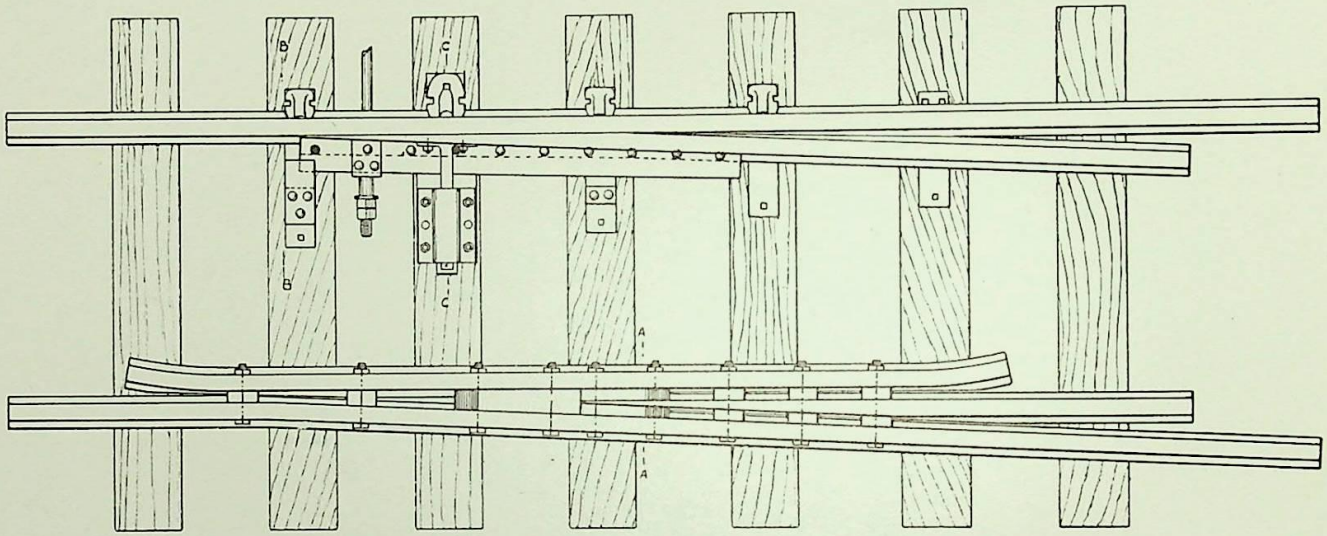
Split Switch for Street Railways

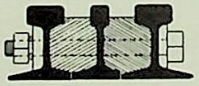


Made either stiff or spring connected. Slide plates are forged in one piece, main rails thoroughly braced. 10 feet or 15 feet long, as desired.

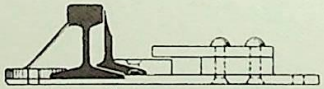
Split Spring Switch and Mate

For Street Railway Turnouts

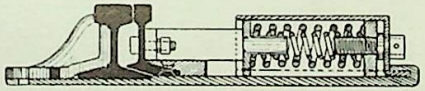




SECTION A-A



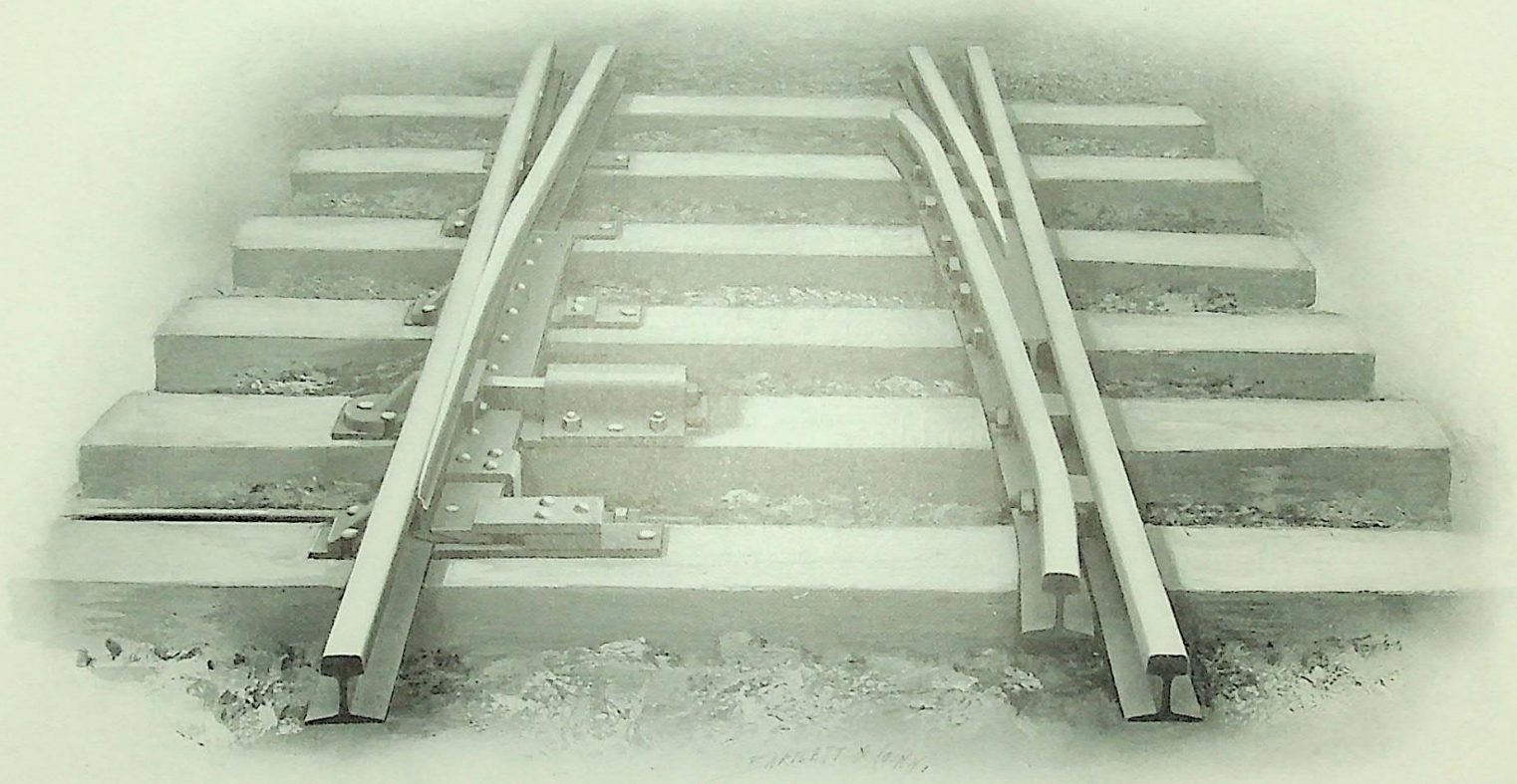
SECTION B-B



SECTION C-C

Split Spring Switch and Mate

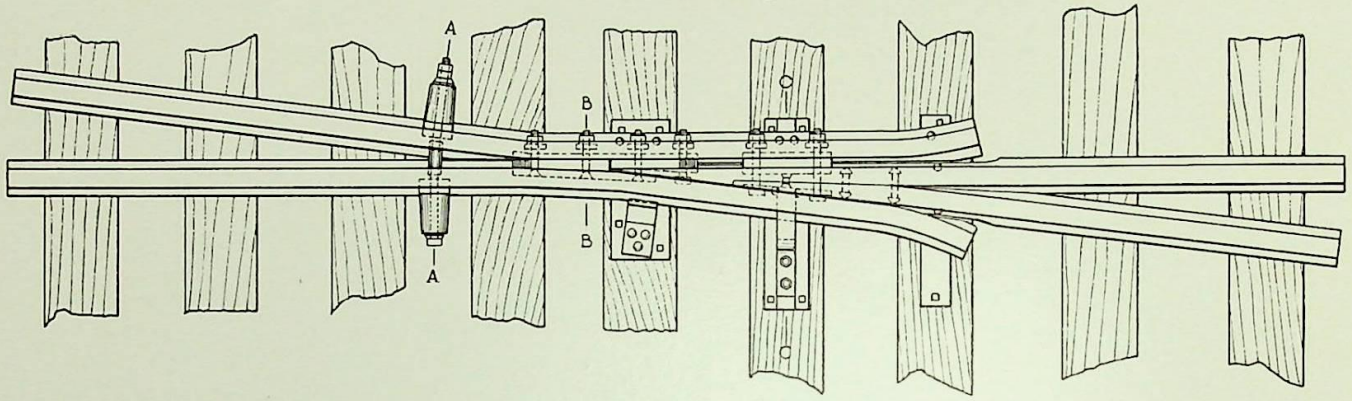
For Street Railway Turnouts



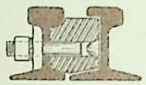
Particularly recommended for turnouts in preference to spring connected split switch, as no part has to move while the weight of the car is on it. Ground lever furnished, if desired, to shift the spring rail.

Single Spring Rail Frog for Street Railways

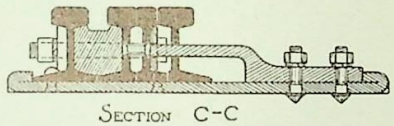
With Raised Filling



SECTION A-A

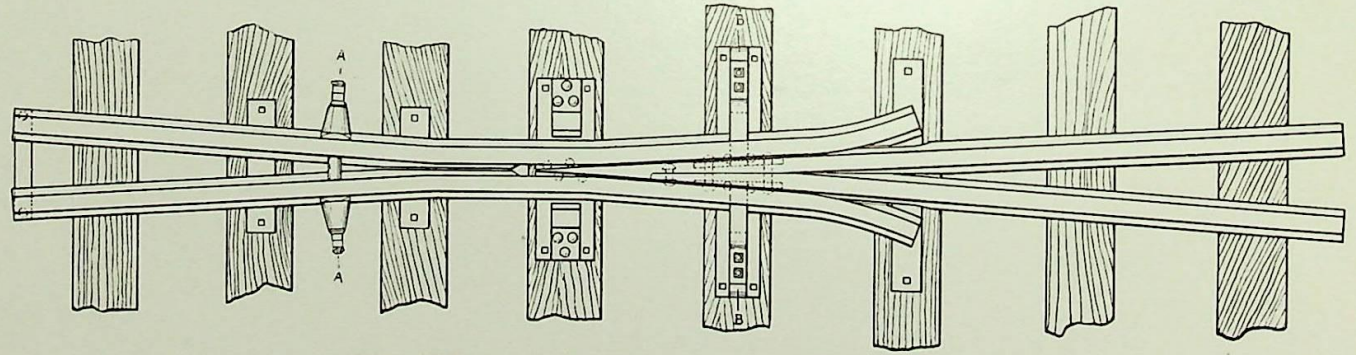


SECTION B-B

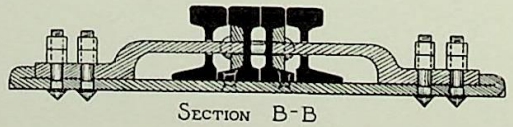


SECTION C-C

Double Spring Rail Frog



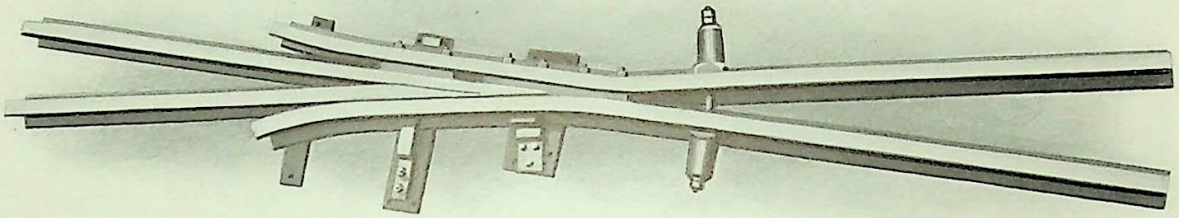
SECTION A-A



SECTION B-B

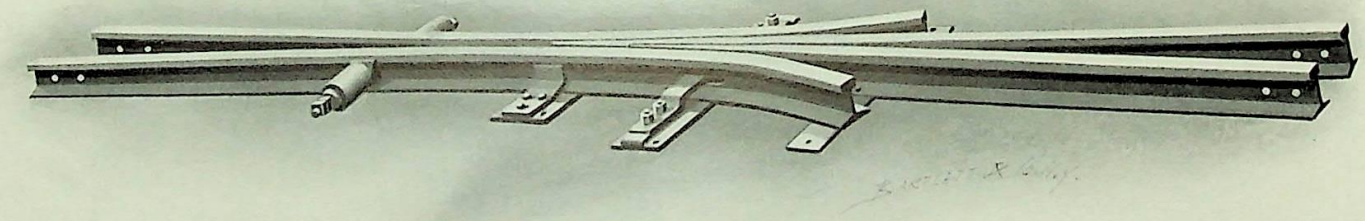
Single Spring Rail Frog for Street Railways

With Raised Filling



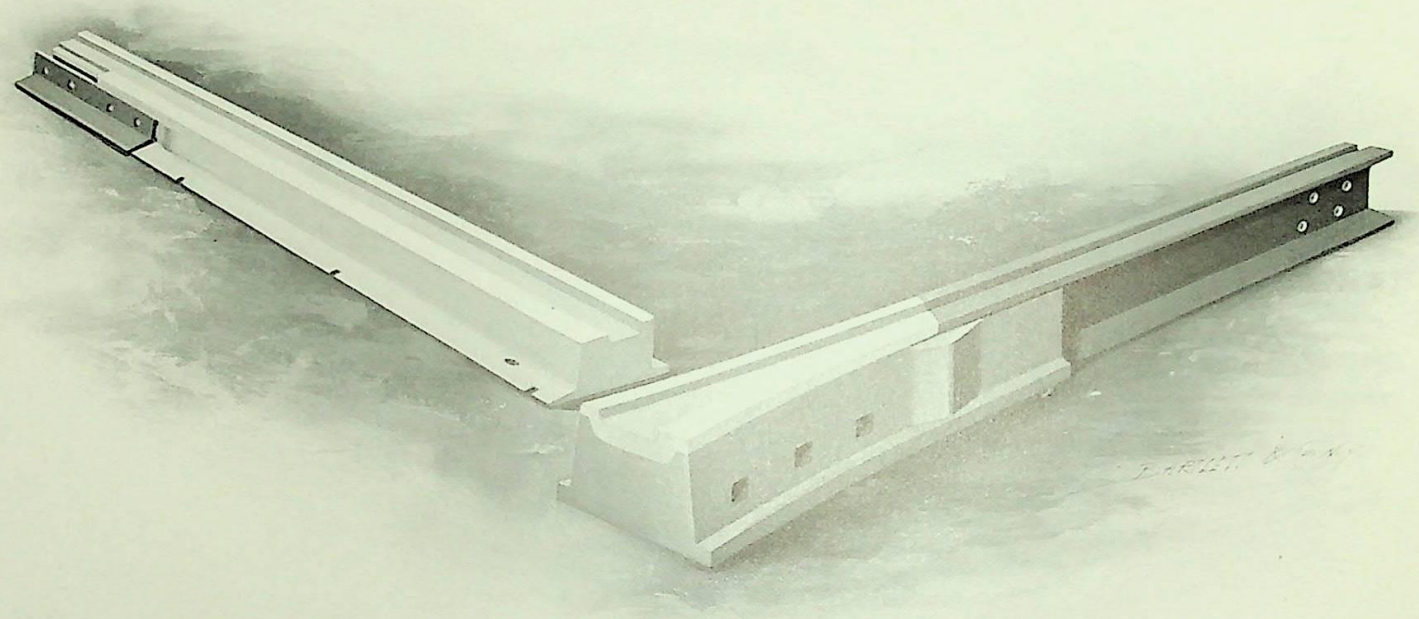
Recommended for sidings in tracks which are exposed above the ties. Smooth running on main track.

Double Spring Rail Frog



Recommended in track used by wheels with different sized flanges, also in turnouts where siding is used regularly. Smooth running on both tracks.

Draw-bridge Funnel Castings for Street Railways



On draw-bridges or similar structures where an uncertainty exists of the two ends of a broken track coming in exact alignment, it becomes necessary to provide guides on the running-on end to direct the cars on to the track. Manganese steel has proved eminently successful in resisting the shocks and severe wear which the guides are subjected to. We furnish them either in solid manganese steel castings, or, in connection with high rails, of a construction similar to our manganese steel girder rail frogs with manganese steel top.

Frog with Different Rail Sections

Cast-welded Combination Rails

Our construction of girder rail and high tee-rail work permits us to use different sections of rails in different ends of the same piece, thus enabling us in most cases to have on the outside ends of a layout the same section of rail as that to be joined to. Or, to the ends of rail arms, we can cast-weld pieces of the same section of rail as that to be joined to. We can also furnish separate cast-welded combination rails as shown. Thus the troublesome compromise joints can be entirely eliminated or reduced to a minimum. When pieces of the same rail as the adjoining one cannot be obtained, or compromise joints cannot be avoided for other reasons, we furnish, wherever possible, forged or cast-steel channel plates, accurately fitted to templates.

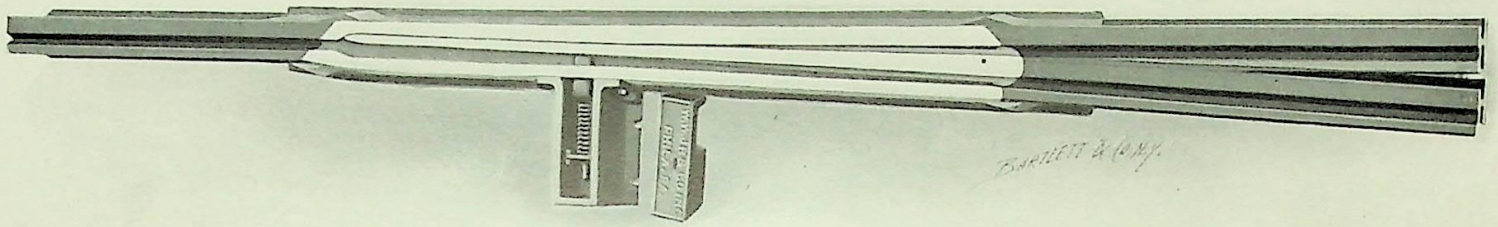
Spring Box for Tongue Switch

OUR spring attachments for tongue switches are so arranged that they can be attached to any of our switches without any special provision being necessary in the tongue. The plunger pushes the tongue above the tongue bed. No pocket is required below the bed. The simple removing of the backing plate in the box will set the spring out of action if desired, and the insertion of ordinary washers in front of the plate will tighten the spring if necessary. The cover of the spring box is so constructed that it cannot be displaced by wagons or horses, but is easily removable when desired, by the use of a wire hook.

Tongue Pivot Bearing

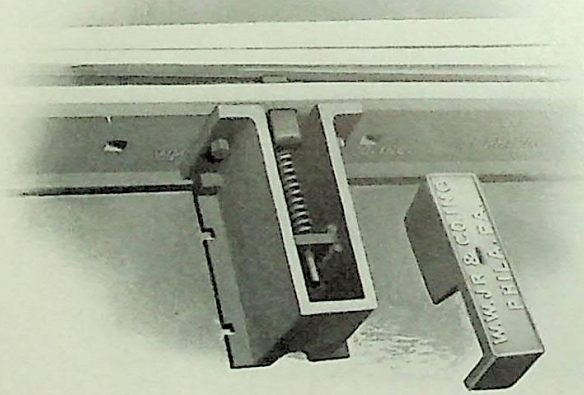
ALL our tongue switches of the higher classes of work are provided with steel bearings into which the tongue pivot fits snugly, and so arranged that the wear can readily be taken up without disturbing the paving. The snug fit is quite sufficient to hold the tongue firmly down. The tongue can be removed when desired by inserting two chisel-pointed bars into the notches on each side of it, near the heel, and by pressing down on them, working the tongue from side to side, and at the same time tapping the tongue with a hammer, it will gradually rise. The bearing is compressible by driving a key or wedge, which can be reached on our regular tongue switches through a small hole in the tongue right over the key. Insert a piece of steel through this hole and drive down the key by it with a hammer. This will tighten the bearing, which should thus always be kept snug. The tongue pivot should not be allowed to wear too loose before tightening the bearing, as it may then be too late to make it snug. If the key cannot readily be driven down, take out the tongue and clean out the slit in the bearing. The wear can be taken up until the slit is entirely closed.

Tongue Switch, with Spring Box, for Turnouts

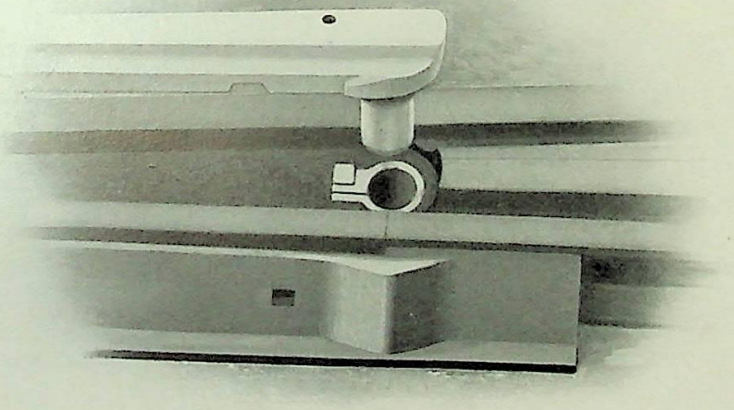


Spring pushes the tongue. No pocket in tongue bed to choke up with dirt and ice.

Spring Box and Cover

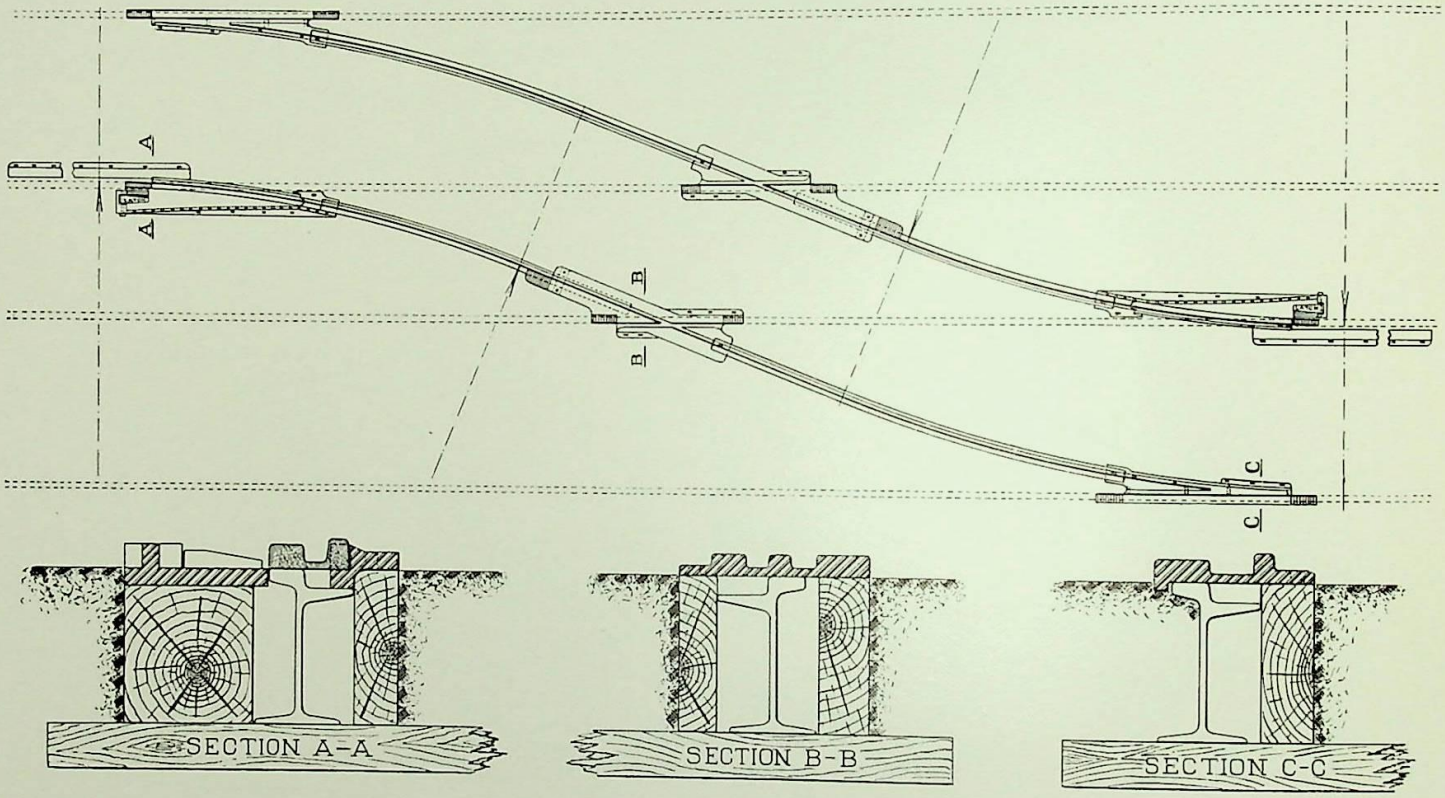


Tongue Pivot Bearing



Takes up the wear. Easily tightened without taking up the paving.

Portable Crossover

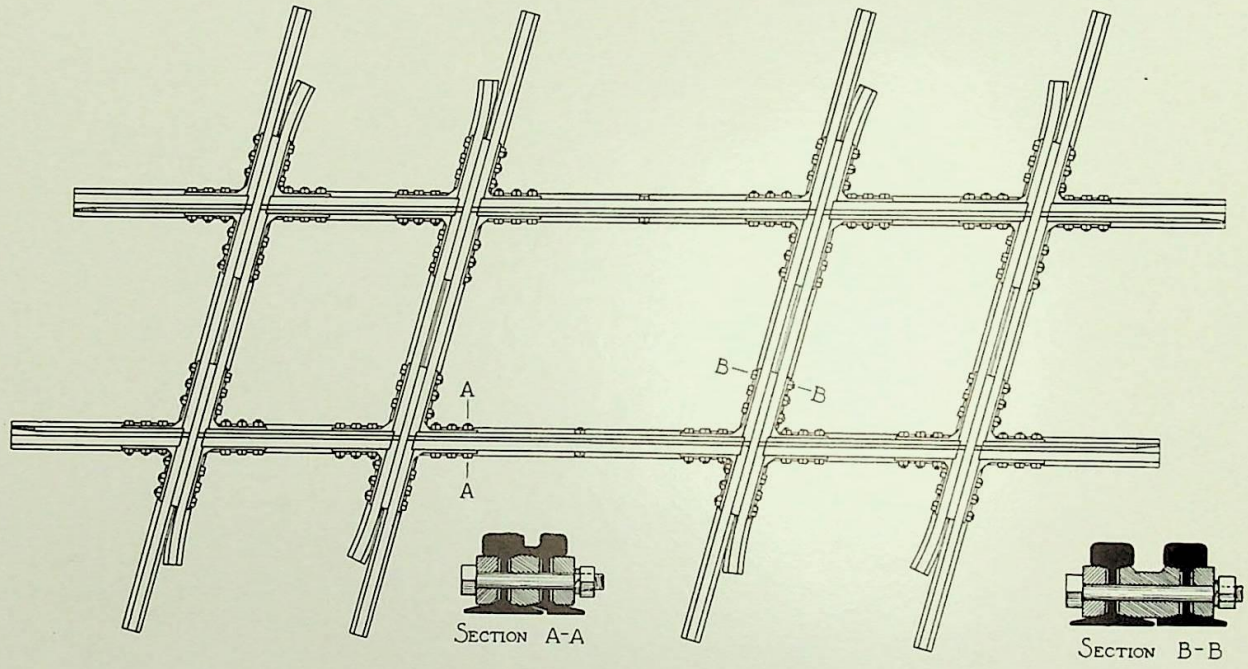


Adapted to any section of girder or tee rail in main track. Unbroken main line switch. Mate and frog made of cast steel. Switch pieces to be spiked to timber placed alongside of rails in main track. Simple and substantial construction adapted for hard service in track construction work.

Crossings—Street Railway Over Steam Railroad

Crossings—Street Railway Over Steam Railroad

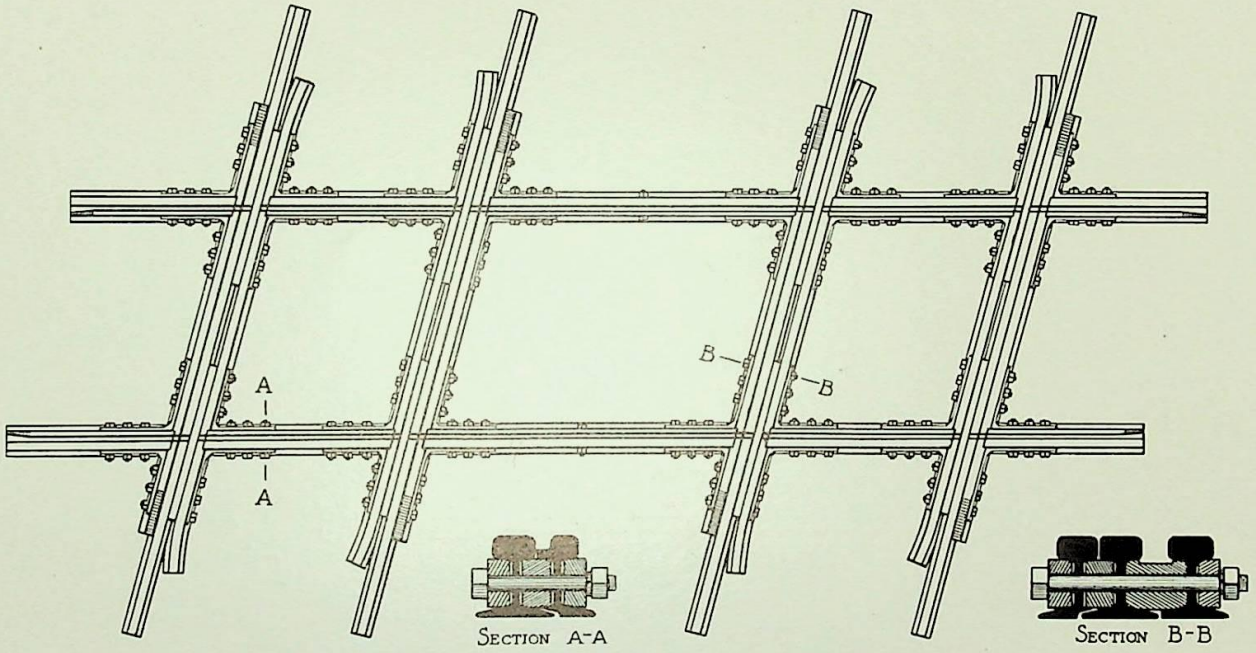
Two-rail Type



Cast iron and cast or rolled steel fillers as may be desired. Knees are heavy forgings reinforced in the corners. Note absence of intermediate joints in street railway rails. Pratt patent planed guard rail for street railway. See section *A-A*. Patented April 23, 1895. The rails of steam railroad run through the crossing.

Crossings—Street Railway Over Steam Railroad

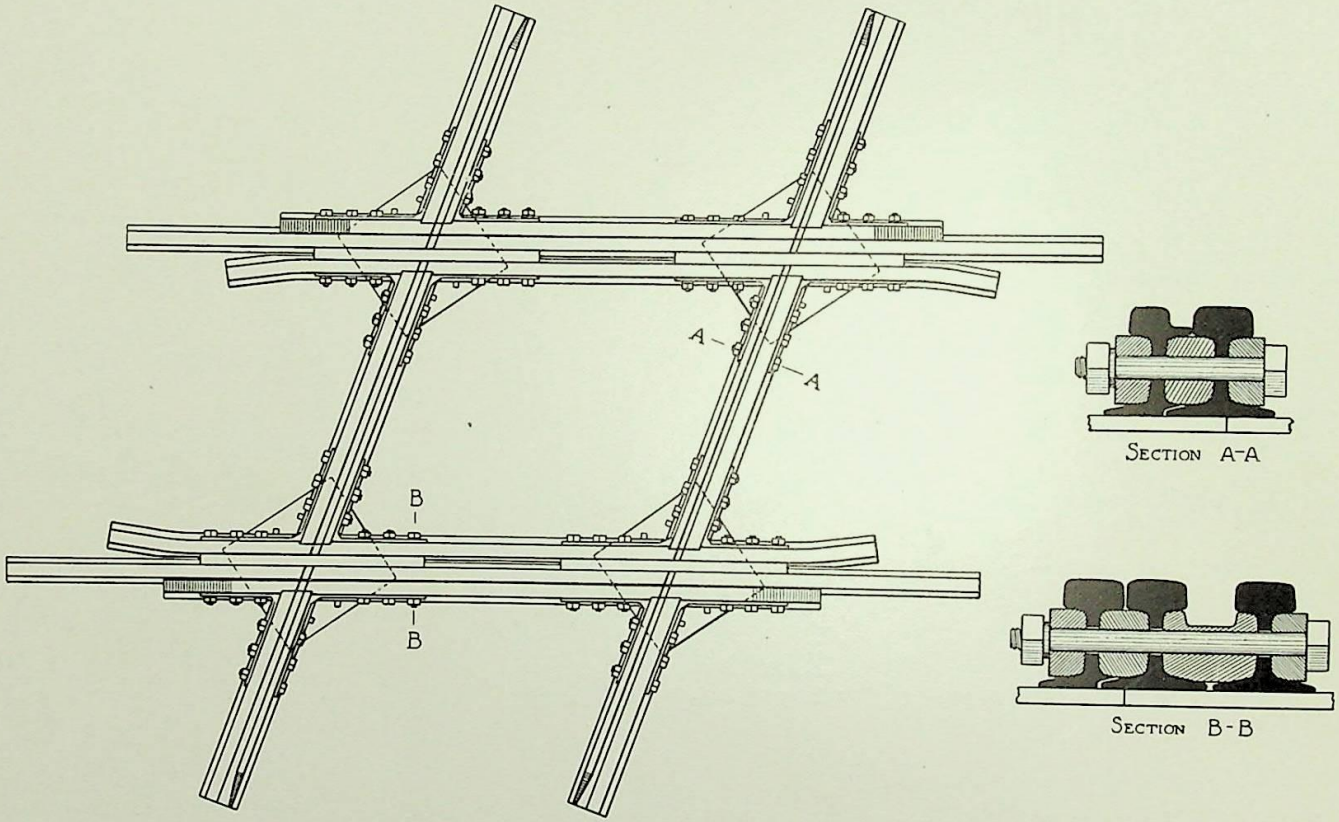
Three-rail Type. Pennsylvania Railroad Standard



Third rail to carry overhanging portion of steam railroad wheels and to prevent worn wheels from striking crossing rails. No intermediate joints in street railway rails. Heavy forged reinforced knees. This type used by the Pennsylvania Railroad Company. The rails of steam railroad run through the crossing.

Crossing—Street Railway Over Steam Railroad

Three-rail Type

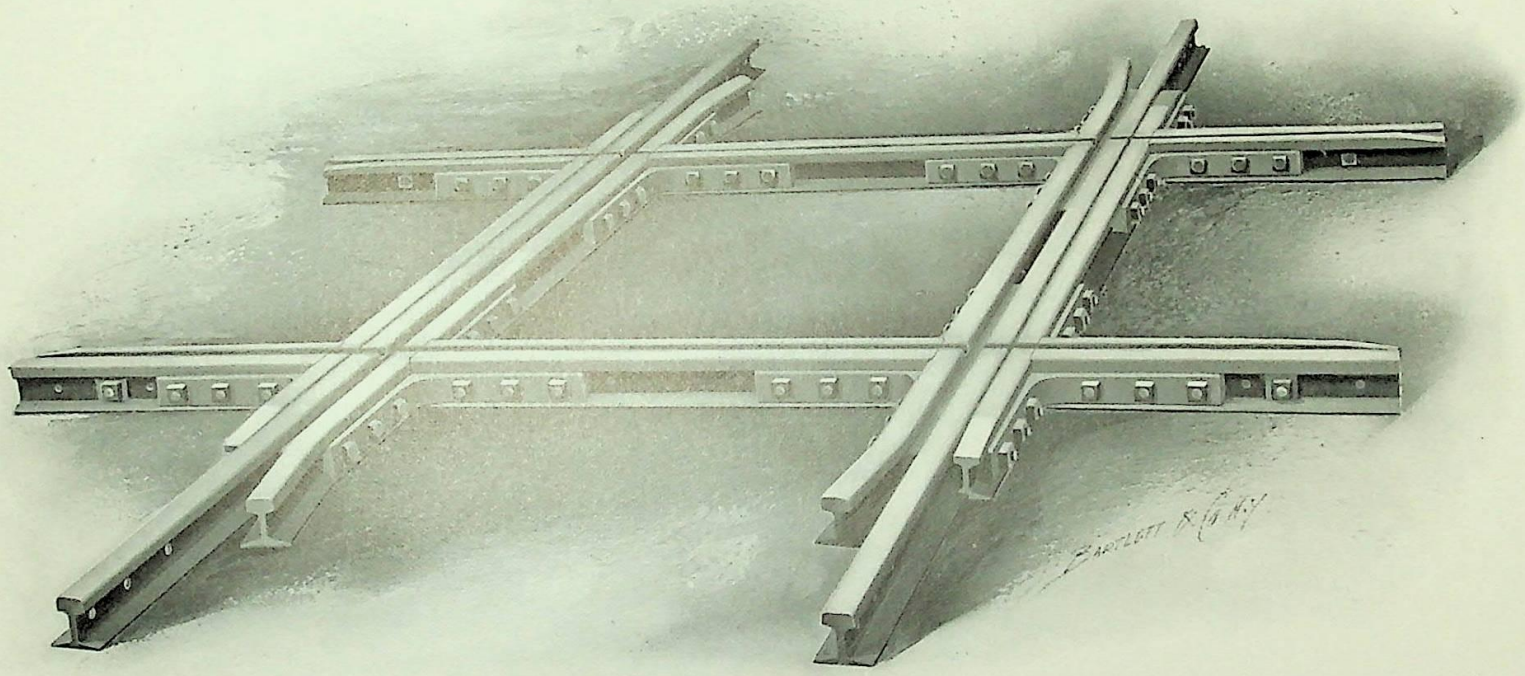


Same as on preceding page, but with steel plates under the corners to give greater strength and stability.

The rails of steam railroad run through the crossing.

Crossing—Street Railway Over Steam Railroad

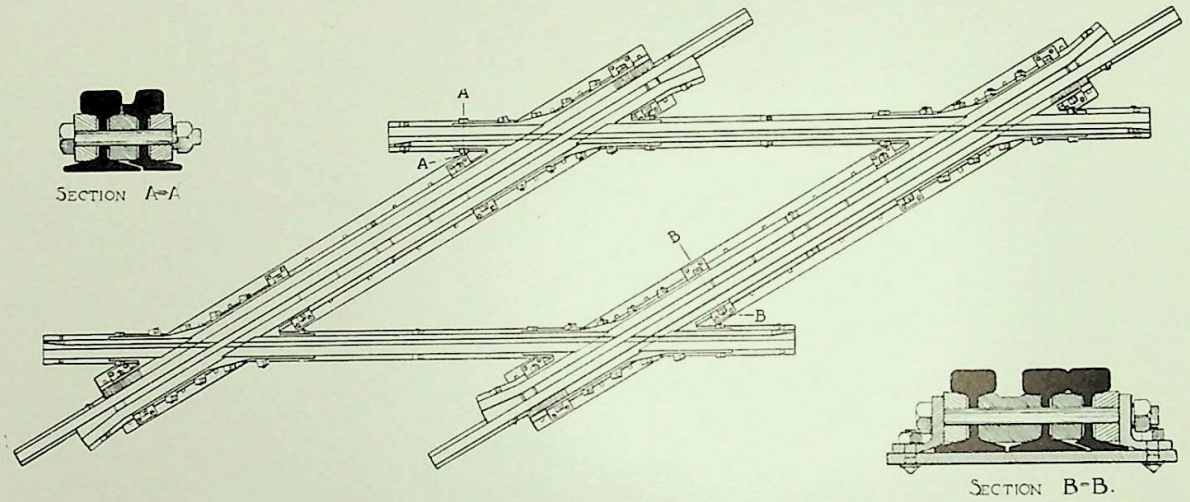
Three-rail Type. Pennsylvania Railroad Standard



Note heavy reinforcement knees. Rolled steel fillers. No joints in the street railway rails between the steam railroad rails. The rails of steam railroad run through the crossing.

Crossing—Street Railway Over Steam Railroad

Three-rail Type. New England Standard

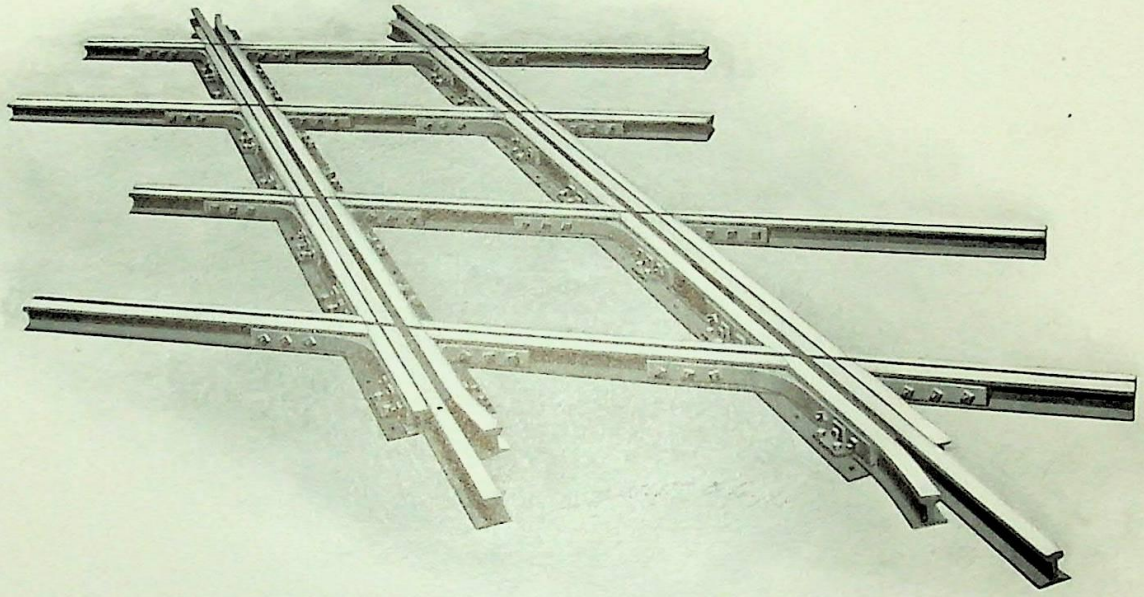


Same as on preceding pages, but with continuous steel plates under steam railroad track, secured by clamps, so that rails can be easily renewed when necessary.

The rails of steam railroad run through the crossing.

Crossing—Street Railway Over Steam Railroad

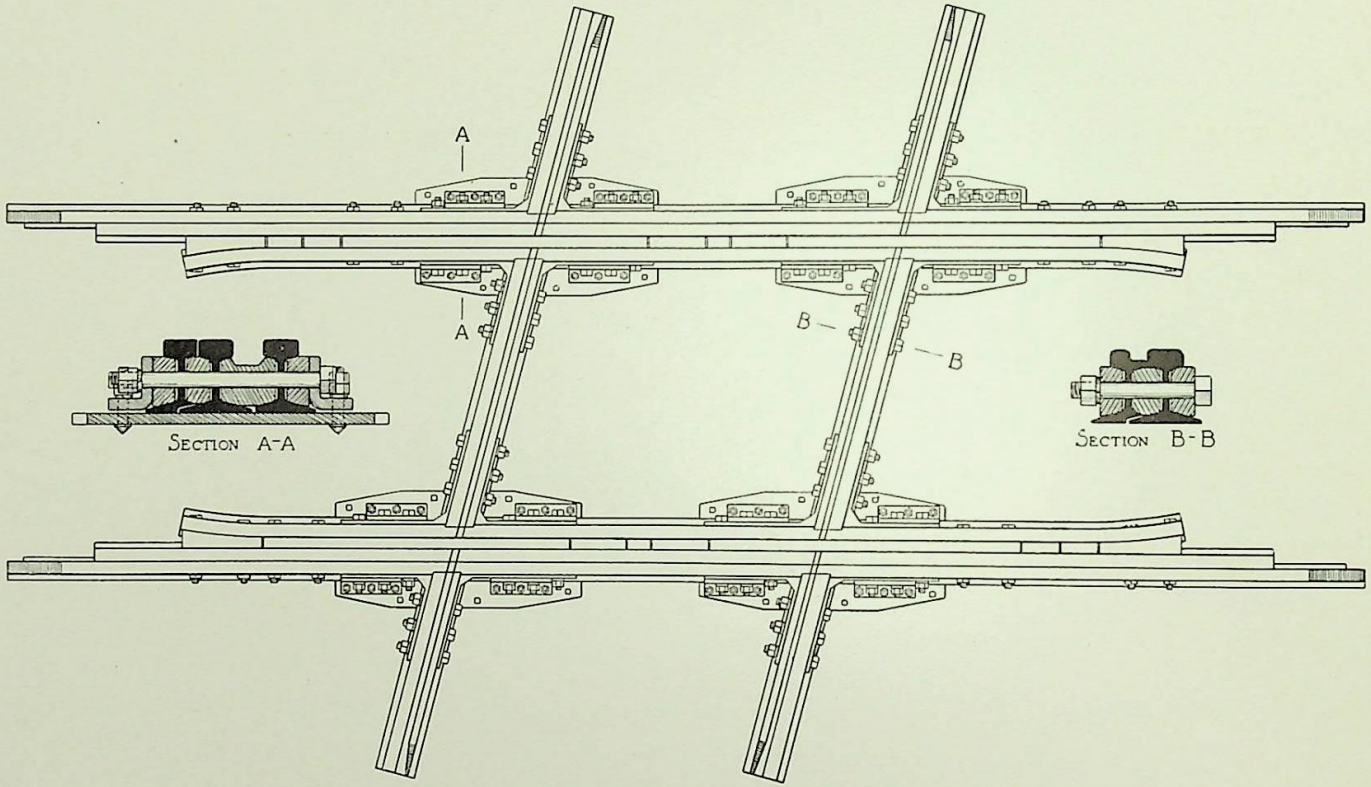
Three-rail Type. New England Standard



Same as on the opposite page, with continuous steel plates under steam railroad track.
The rails of steam railroad run through the crossing.

Crossing—Street Railway Over Steam Railroad

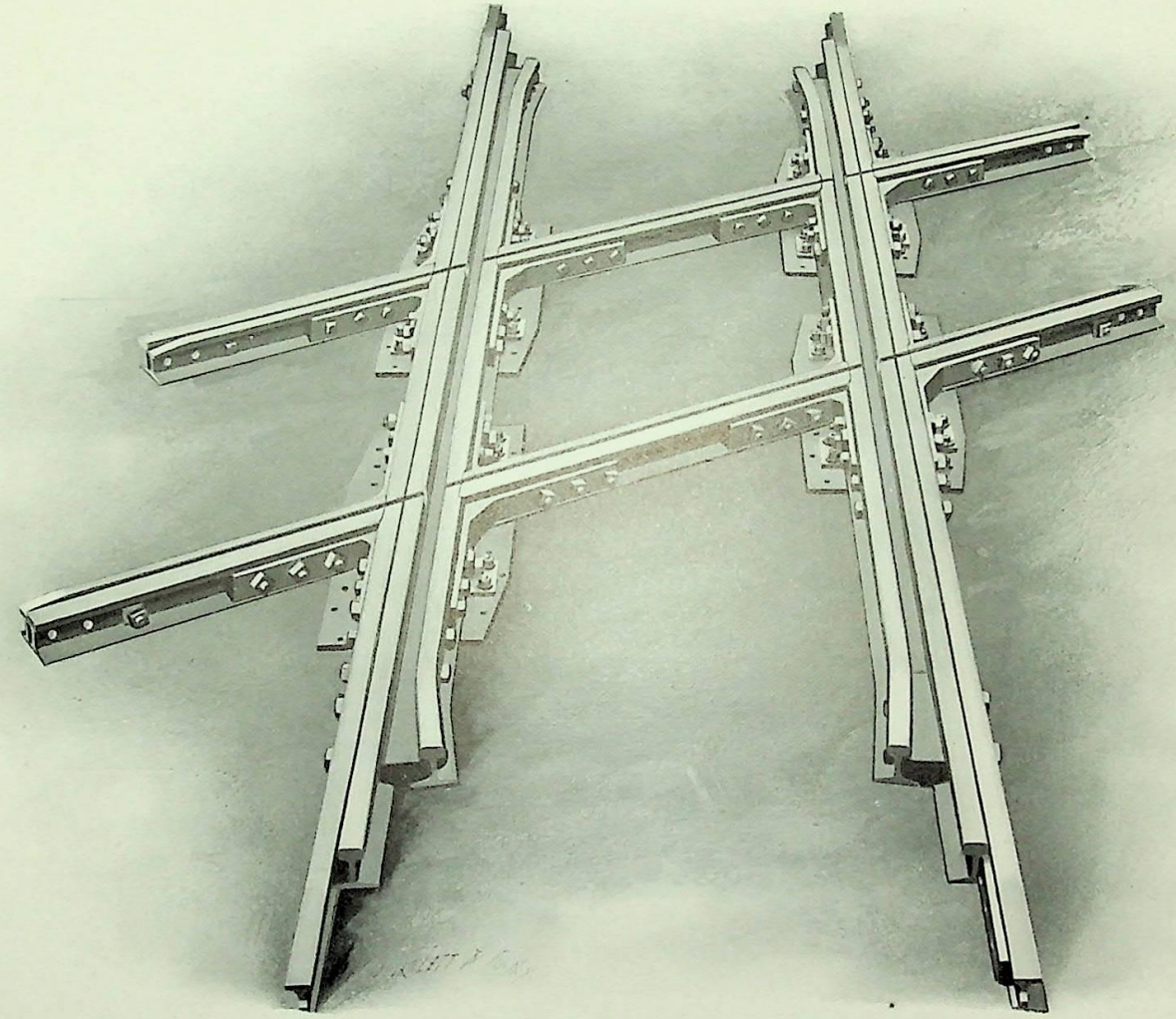
Three-rail Type. Philadelphia & Reading Railway Standard



The rails of steam railroad run through the crossing.

Crossing—Street Railway Over Steam Railroad

Three-rail Type. Philadelphia & Reading Railway Standard

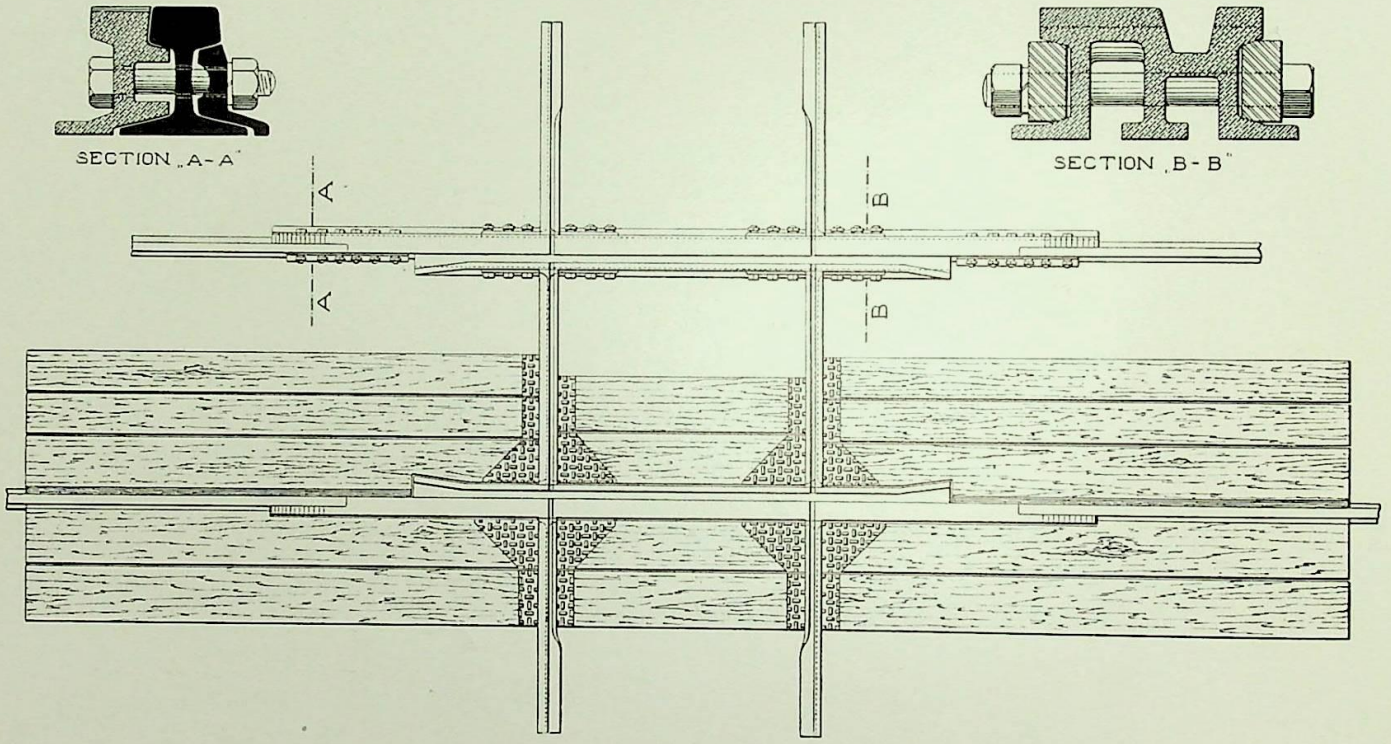


Note projecting third rails to bridge the joints in main rails, also heavy steel plates under corners, secured by clamps. The rails of steam railroad run through the crossing.

Crossing—Street Railway Over Steam Railroad

With Manganese Steel Rails on Steam Railroad Track

Nichols Patent August 29, 1899



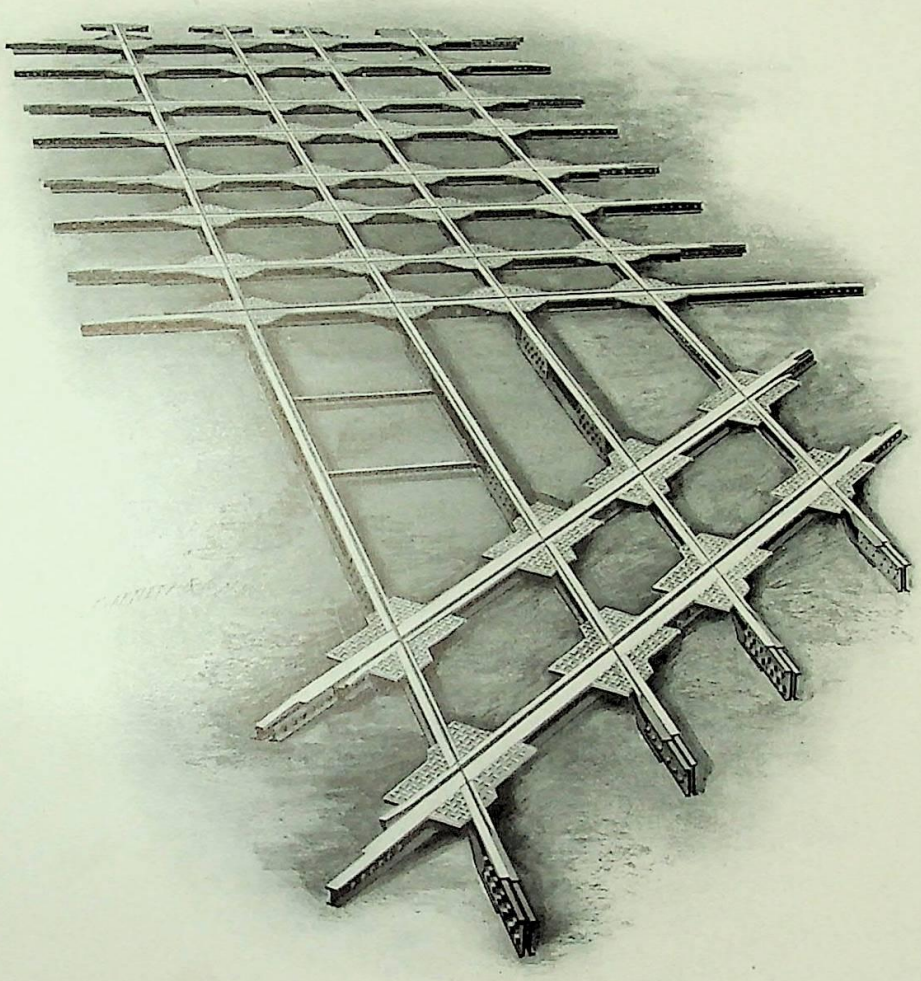
The manganese steel rails are continuous.

Group of Crossings—Street Railway Over Steam Railroad

With Manganese Steel Rails on Steam Railroad Tracks

Nichols Patent, August 29, 1899

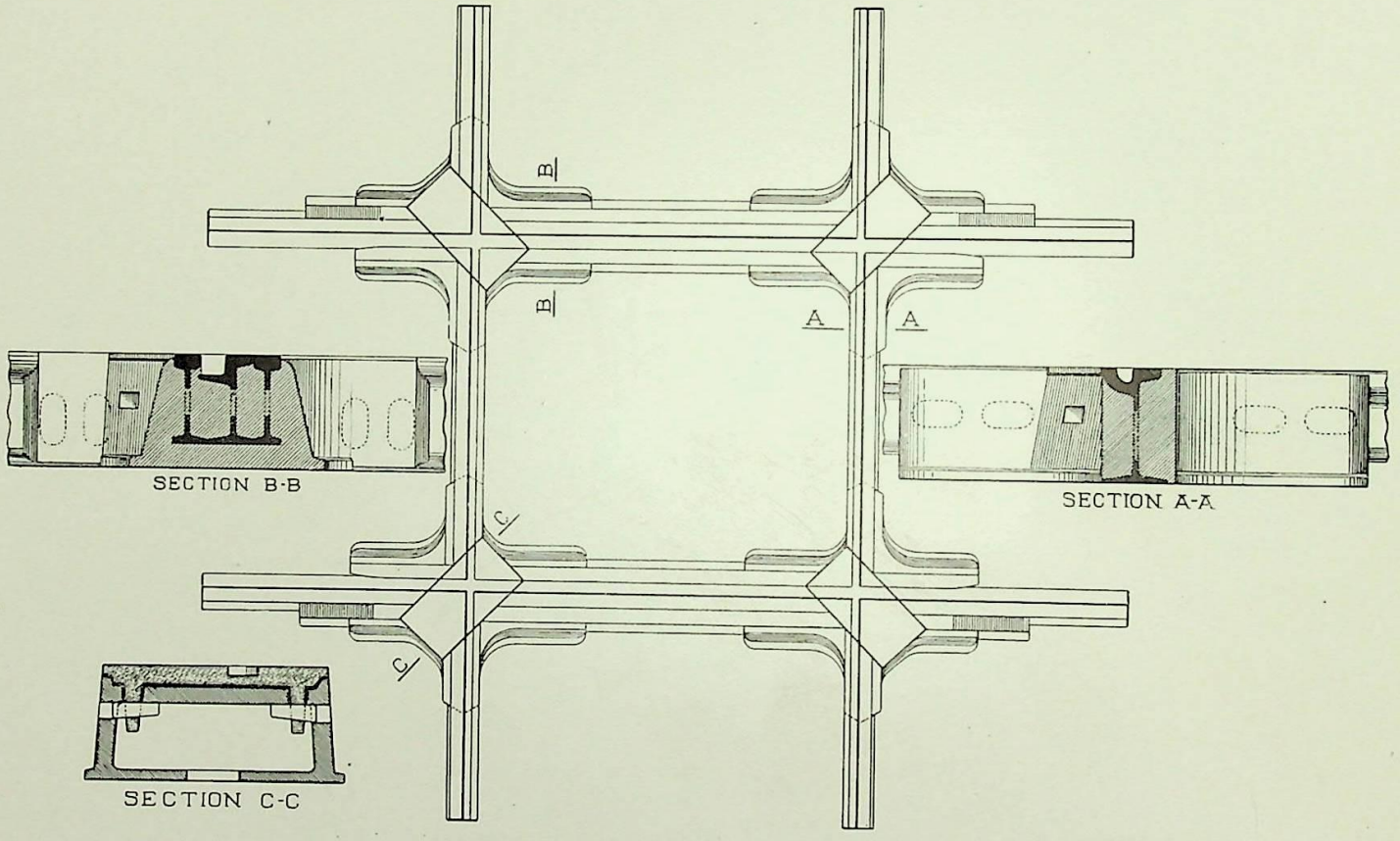
HEREWITH is shown a group of this style of crossing as laid out before shipment. The usual running rails, guard rails, third rails and fillers in steam railroad track are combined into solid manganese steel castings. The street railway track is formed of steel castings or rolled rails as desired. With steel castings only one-half the regular number of bolts are required. Last four or five times as long as crossings built of tee rails in steam railroad track. Note cover plates in corners to make bolts easily accessible.



Crossing—Street Railway Over Steam Railroad

Manganese Steel Center Construction

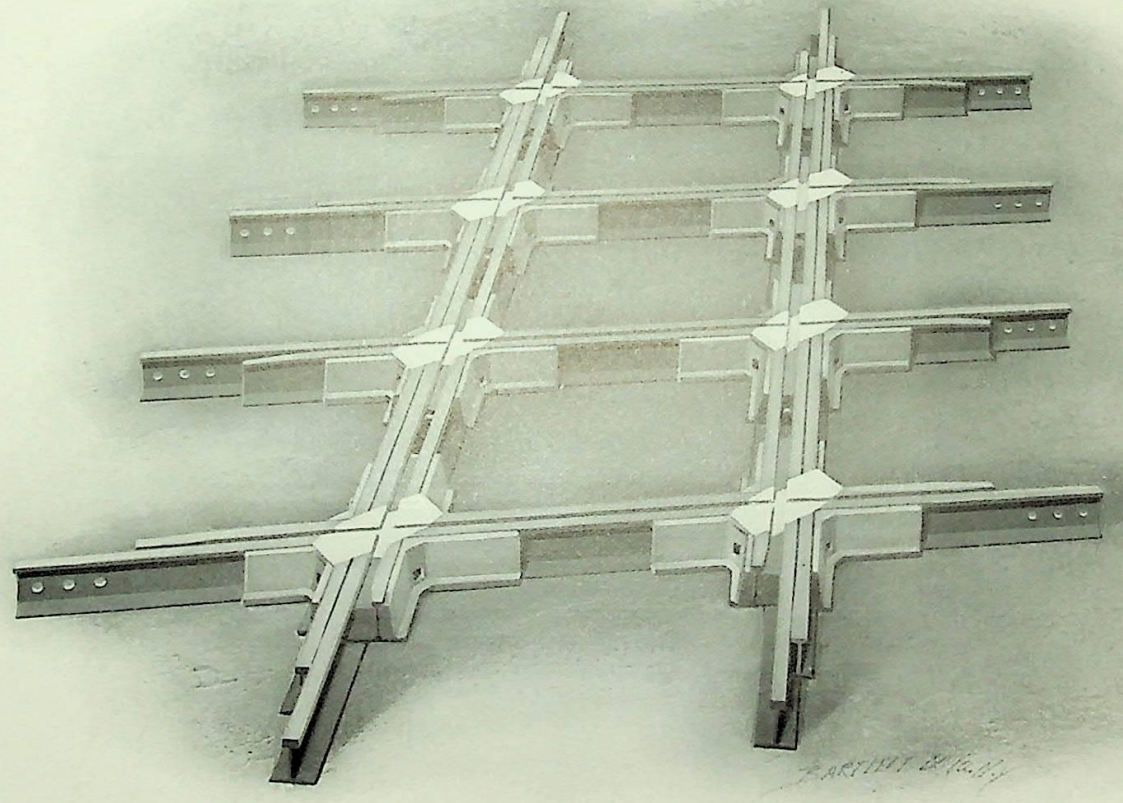
Patented May 16, 1894; June 5, 1894; September 3, 1895



Crossings—Street Railway over Steam Railroad

Manganese Steel Center Construction

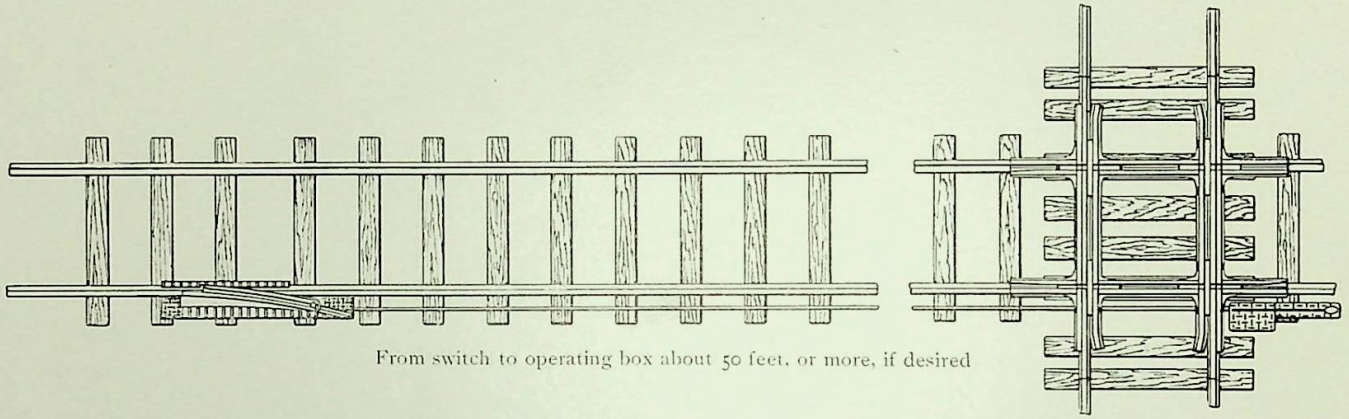
Patented May 16, 1893; June 5, 1894; September 3, 1895



Recommended for steam railroad tracks crossing street railway tracks in paved streets. Made like manganese steel center construction for street railways, but extra heavy.

Derailing Switch

Patented September 12, 1893; and Porter Patent March 10, 1896



From switch to operating box about 50 feet, or more, if desired

The derailing switch is a safety appliance for places of danger, which cars may have to cross. The Porter Derailing Switch consists of an operating mechanism placed at or near the railroad crossing and a switch, normally and automatically set to derail cars, placed some distance ahead of the crossing, and so arranged that it can be opened to allow a car to pass only by the operating mechanism. The conductor must therefore precede the car to the point of danger, and remain there holding the operating lever until the car has passed the switch, when by simply dropping the lever, the switch will automatically return to the derailing position. For the operating mechanism, we usually furnish a lever in a cast-iron box, set flush with the street surface and protected from injury by wagon traffic. For the switch we recommend our unbroken main line style (see page 26) with a box containing the automatic mechanism underneath it. If preferred, we can furnish ordinary tongue switch or split switch in its stead. The connection between the switch and operating lever consists of a wire or wire cable encased in iron pipe placed underneath the street surface. For single track roads we make the switch "spring connected," so that it will allow a car coming from the crossing to pass by the action of the wheel flange against the heel of the tongue.

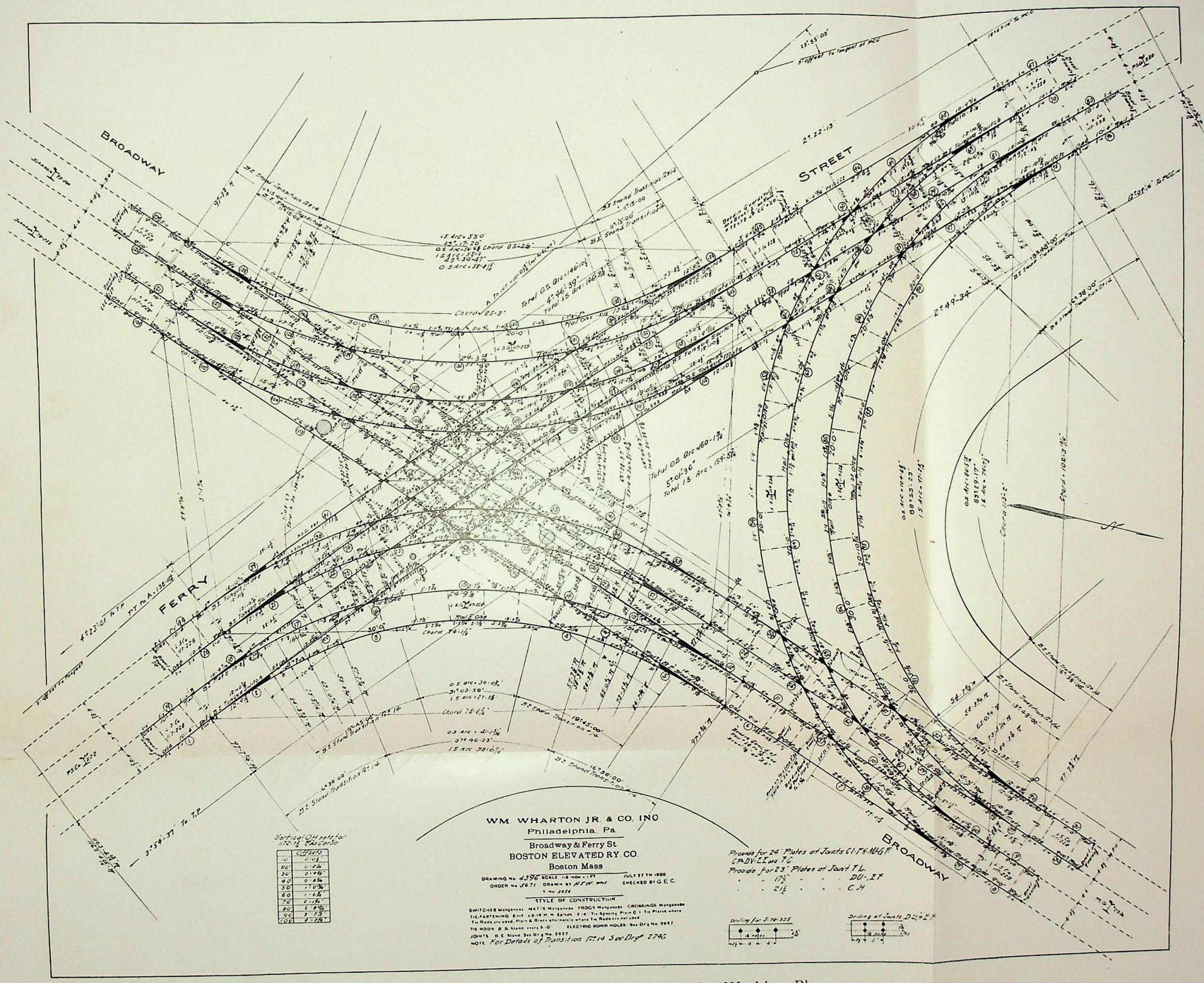
We also furnish switches alone, without operating mechanism, for connection with interlocking systems.

Layouts of Street Railway Special Track Work

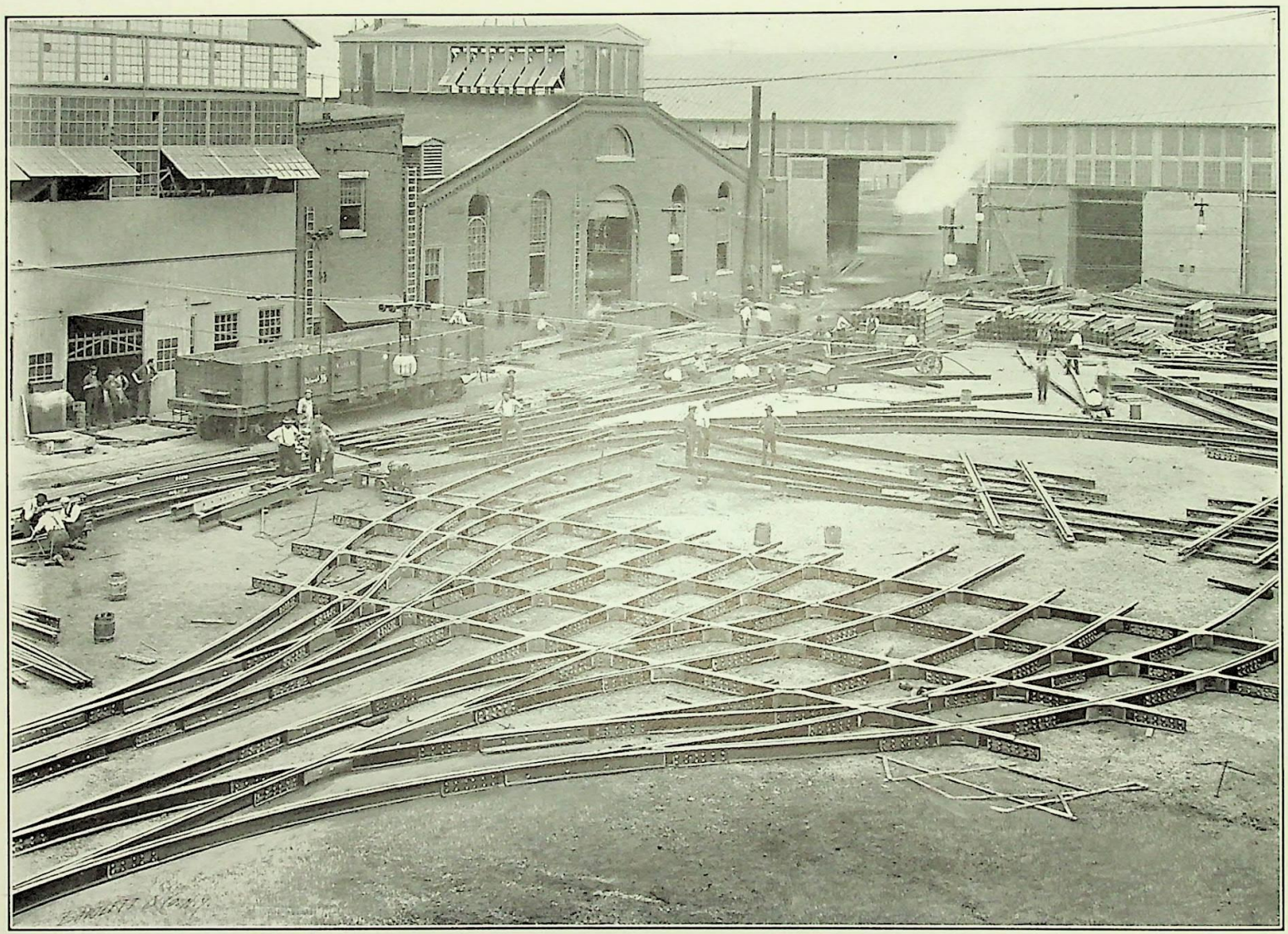
The Fitting Up and Laying Out of Special Track Work

ALL our work is fitted together and laid out complete, tested as to measurements, etc., and carefully inspected before shipment. All parts are marked with the name of the purchaser, the location of the layout, if known, and a piece number. A working plan is furnished with each layout, giving over-all dimensions, angles and starting points, the length of each piece and the number of each piece. Ends of parts meeting each other are stamped with the same letter, so that should the piece number become obliterated the piece can still be identified by the stamped letters on the ends. After the layout is once started it can be put together by simply joining ends bearing the same letter or combination of letters. Special joints are marked with a letter corresponding to those on the ends which they are to join up to. All measurements given are to gauge lines. This system of complete fitting and marking will be found to save considerable time and expense in installing the work.

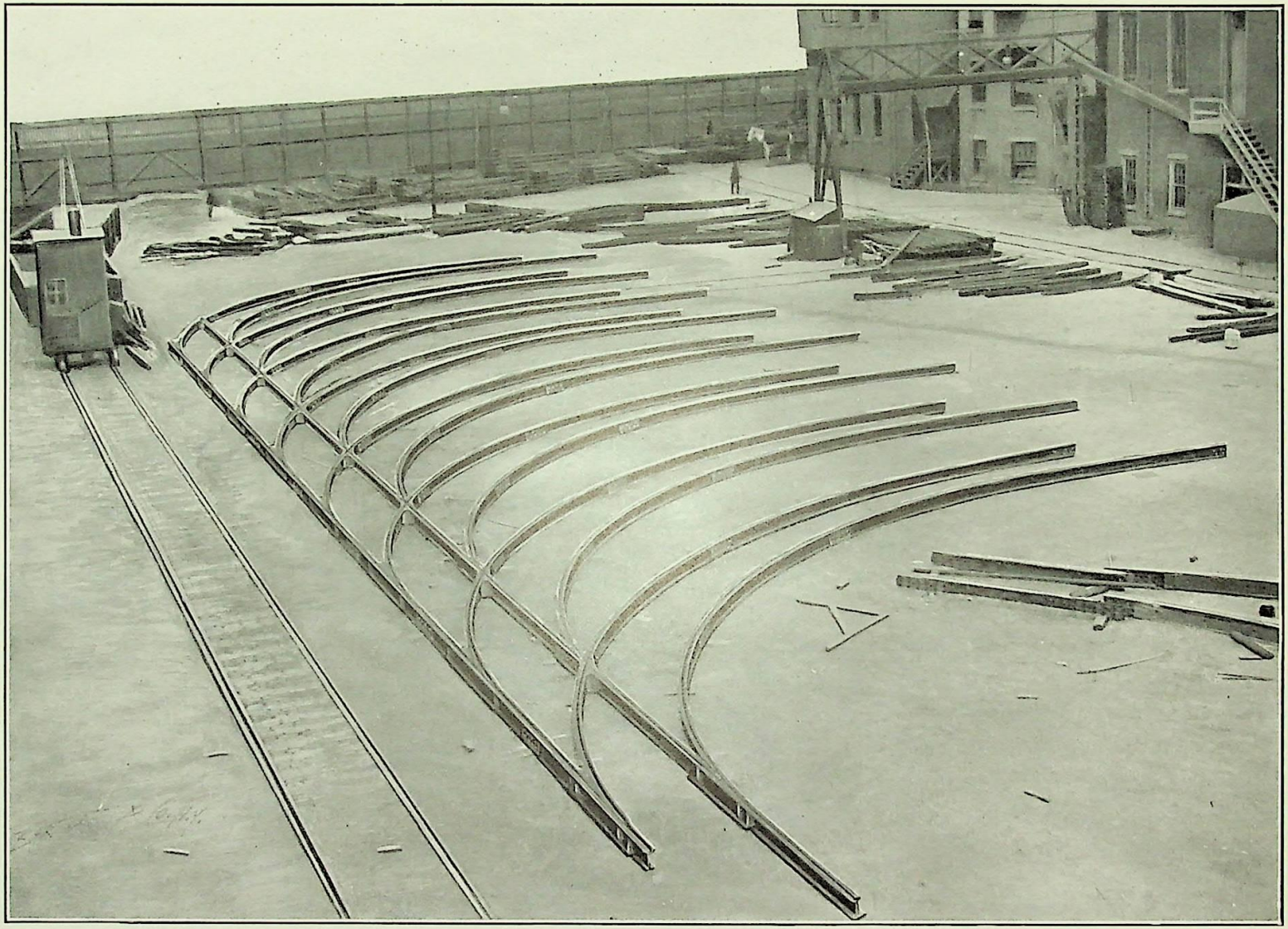
Working plans, as per reduced sample on next page, and list of material are furnished with each layout.



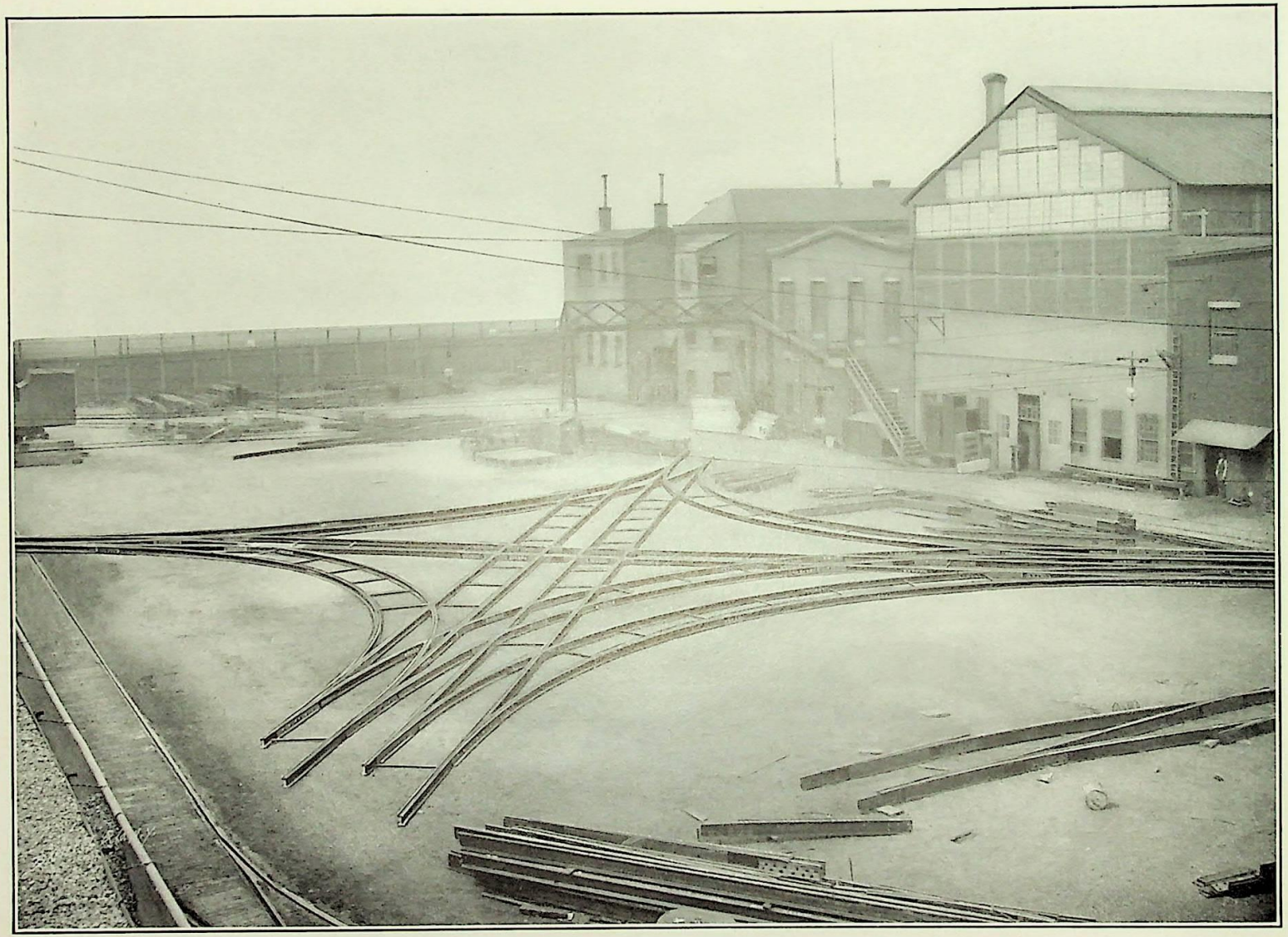
Reduced Photographic Reproduction of a Working Plan



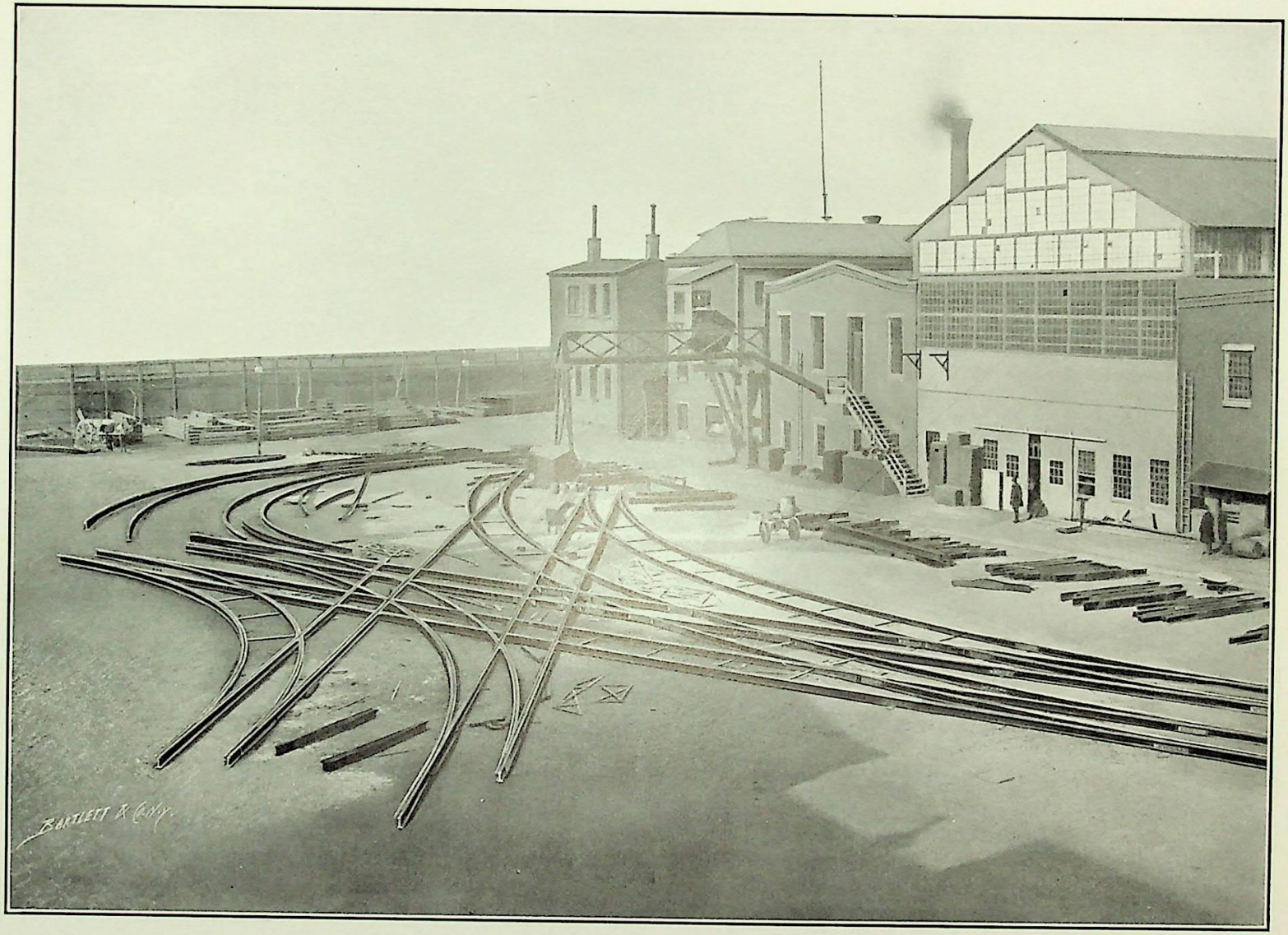
Campello Car-house Layout, Brockton, Mass., U. S. A. Furnished to the Brockton Street Railway Company



Car-house Layout, Hoboken, N. J., U. S. A. Furnished to the Jersey City, Hoboken & Paterson Street Railway Company

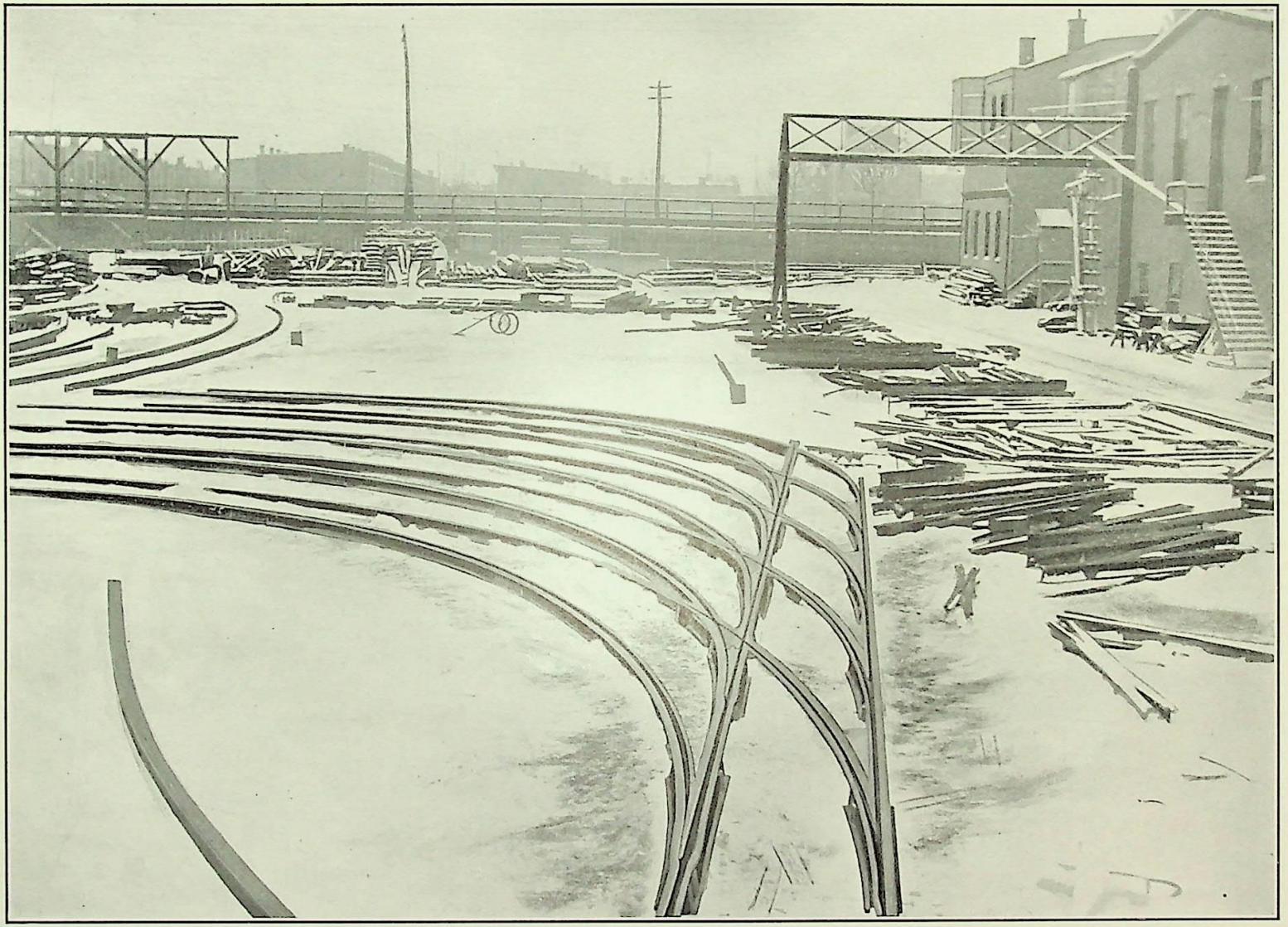


Track Layout for St. James and McGill Streets, Montreal, Canada. Furnished to the Montreal Street Railway Company

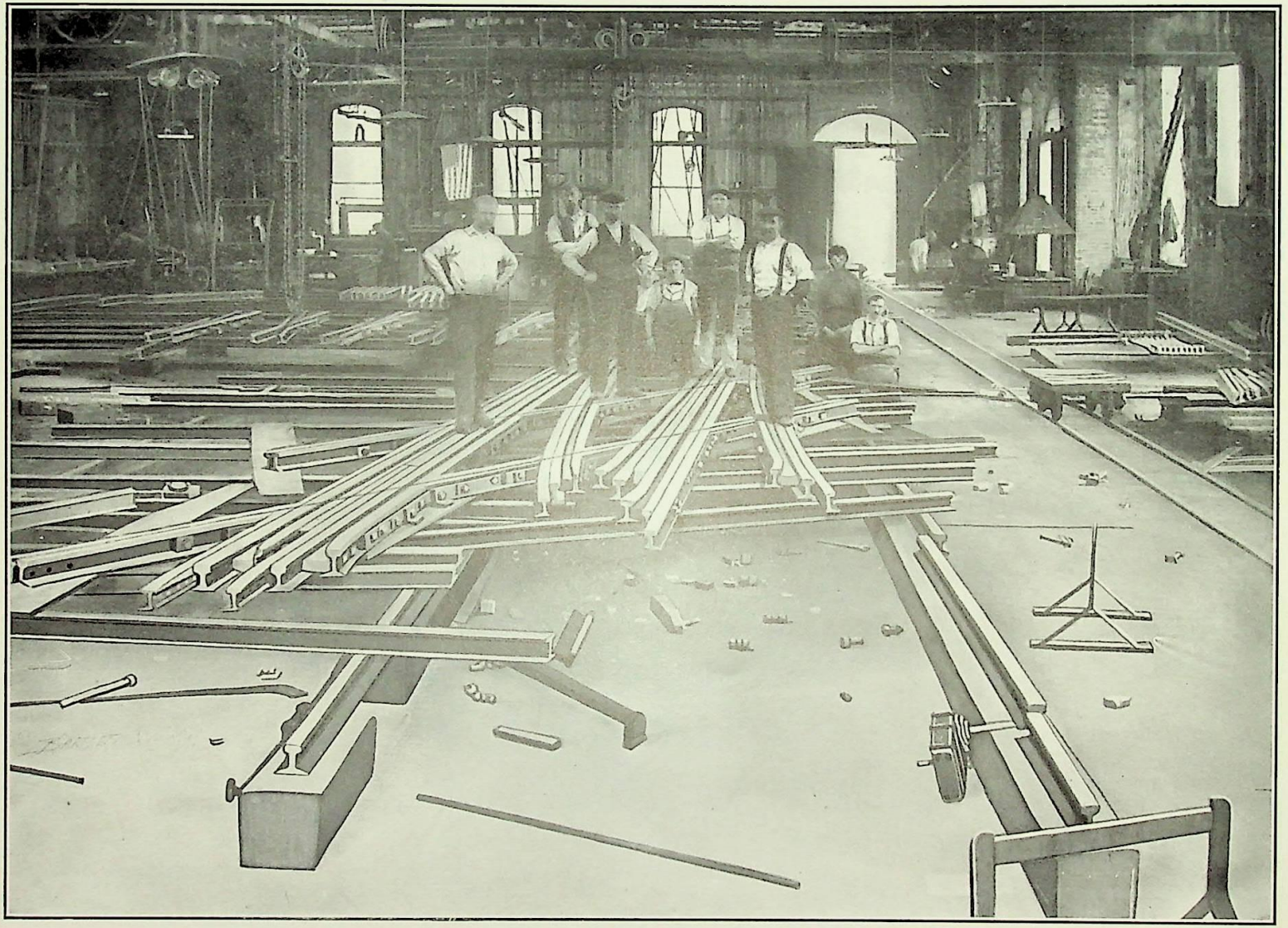


Track Layout at Calzada de Chapultepec and Calle de Bucareli, Mexico City, Mexico. Furnished to the Ferrocarrilles del Distrito Federal de Mexico

Track Layout at Avenida Don Carlos and Calcada do Marquez d'Abrantes for Campanhia Carris de Ferro de Lisboa, Lisbon, Portugal



Car-barn Layout for Perth Electric Tramways, Ltd., Perth, Western Australia

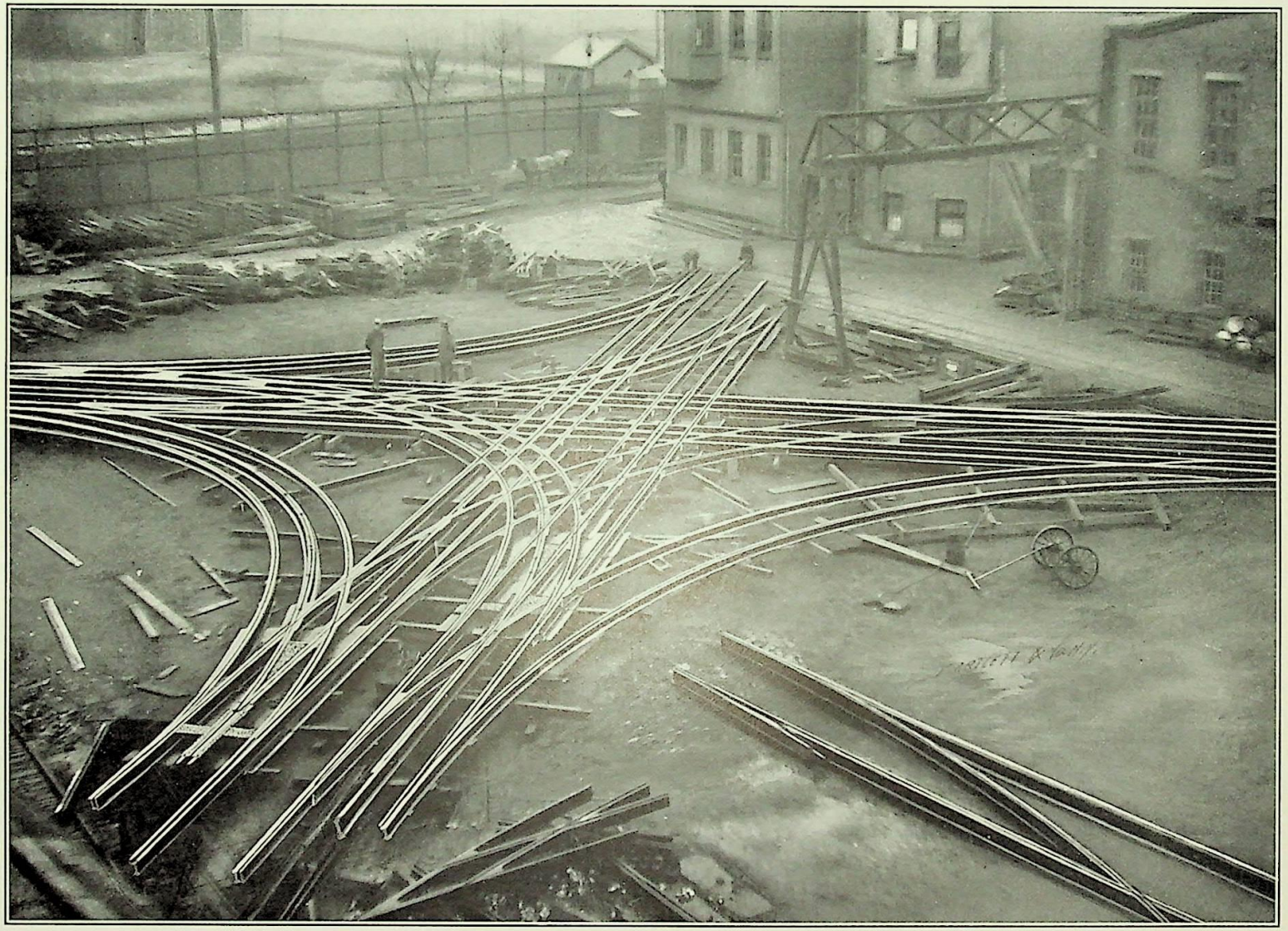


Complicated Crossings for Tenth Street and Philadelphia & Reading Railway, Philadelphia, Pa., U. S. A.

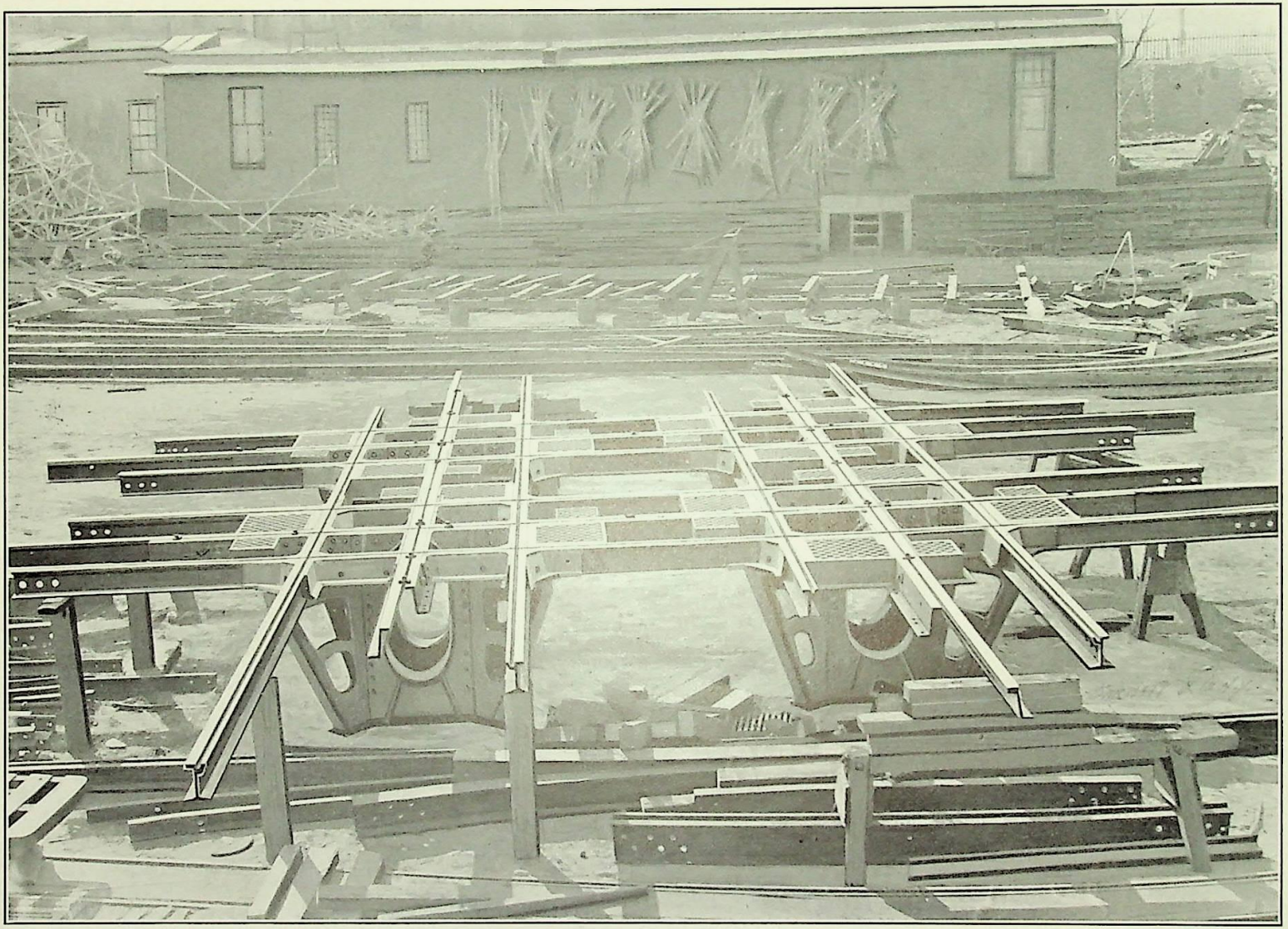
Special Track Work for Cable Railways and Electric Railways with Underground Conduit

WE furnish special track work for conduit railways, either with or without the metallic material for the sub-structure, of our own design or to designs prescribed by the customer, adapting our construction of switches, mates and frogs to the requirements of such designs. The photographs on the following pages illustrate a small variety of such work which we have furnished to various parts of the world.

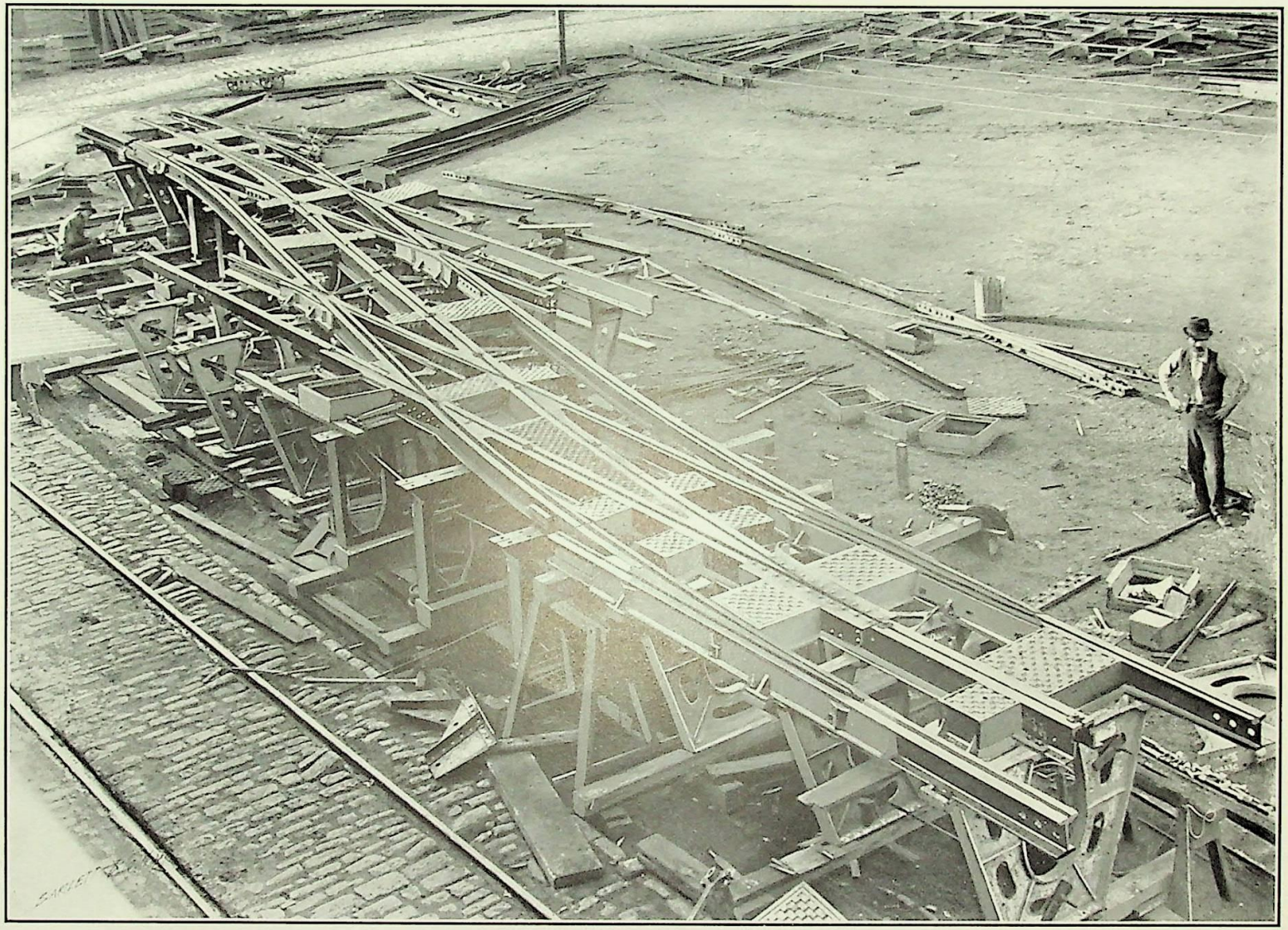
We call particular attention to the introduction of manganese steel at the points where tracks cross the slot.



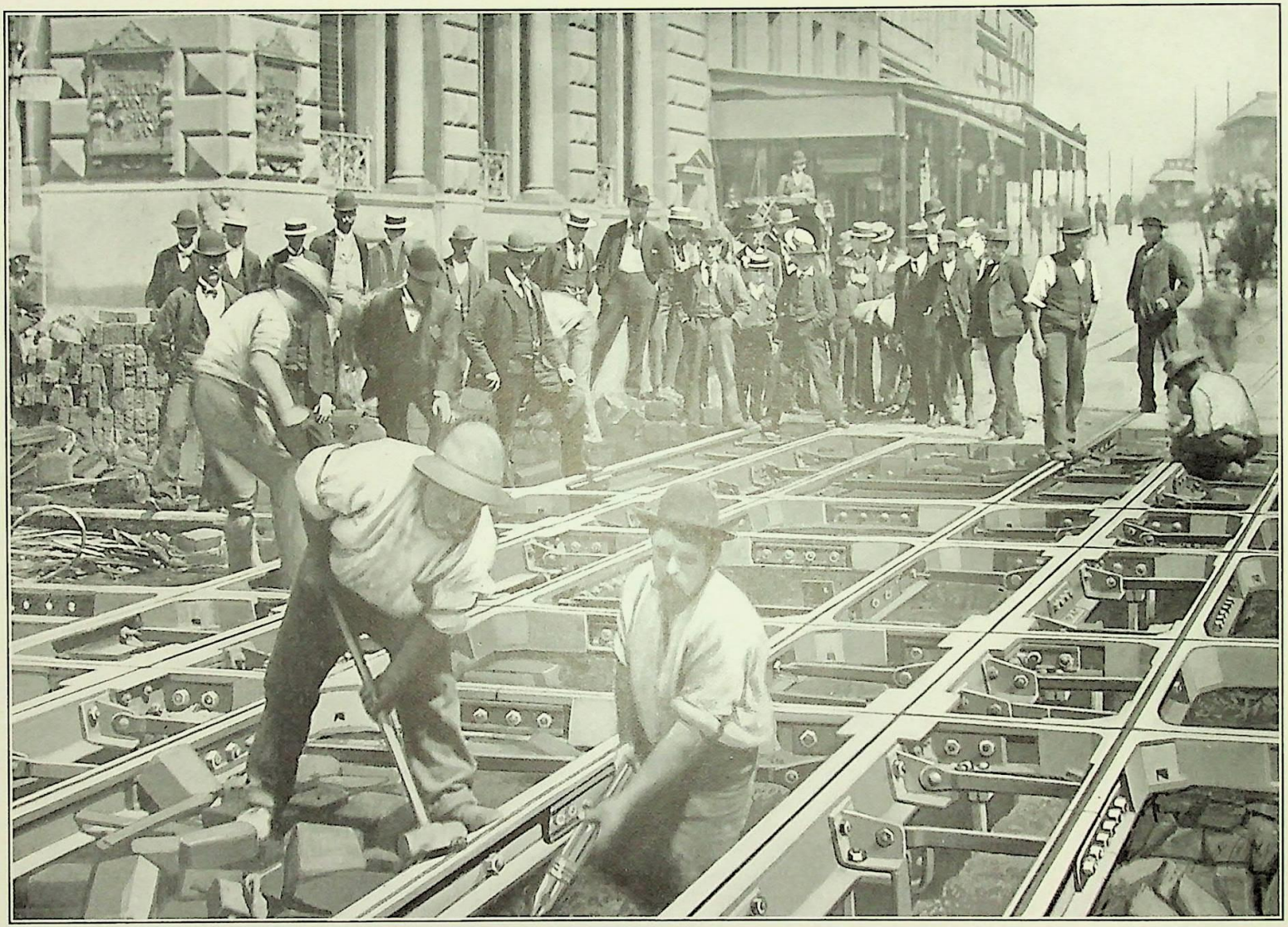
Conduit Track Layout at Sixth Avenue and Twenty-third Street, New York City, U. S. A. For Metropolitan Street Railway Company



Conduit Crossings at Eighth and G Streets, S. E. For Anacostia & Potomac River Railroad Company, Washington, D. C., U. S. A.



Conduit Crossover for Anacostia & Potomac River Railroad Company, Washington, D. C., U. S. A.



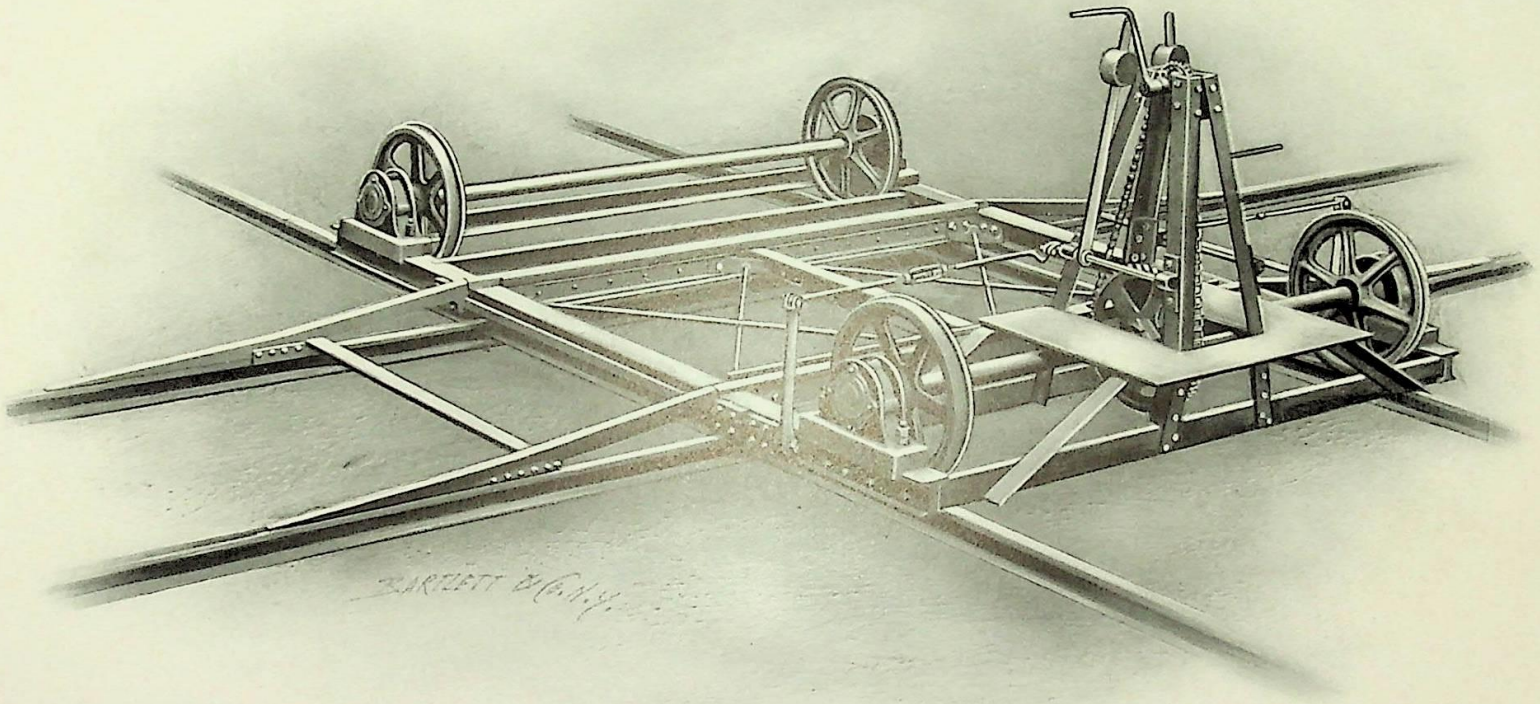
Conduit Crossings on King Street. For New South Wales Government Tramways, Sydney, Australia

Transfer Tables and Turntables for Street Railways

ON the following pages we illustrate some transfer tables and turntables for railways. The conditions in car houses, the weight, length and wheel base of cars vary to such an extent that we generally design transfer tables to suit the particular conditions existing in each individual case, and we will be pleased to submit designs to prospective customers. We furnish tables built on any of the usual principles, *i. e.*, to run in a pit, or with depressed track and shallow pit, or "flush floor" tables, one of which latter is illustrated on the opposite page, and to which we call particular attention.

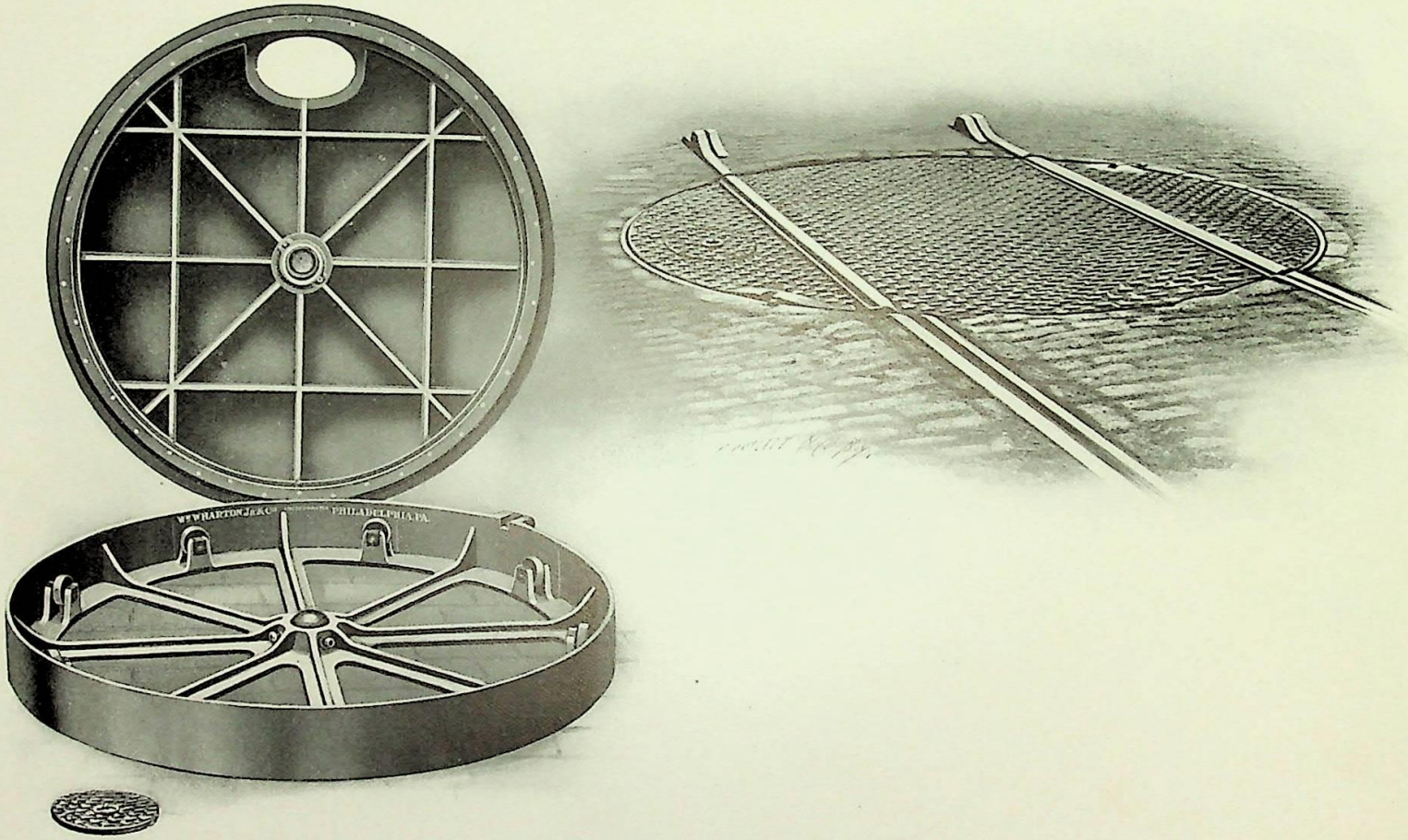
We provide our transfer tables with a hand-propelling gear, or we can make provision for the attachment of an electric motor, or both.

Our turntables for street railways are of substantial and simple construction, as the illustration and detailed description on the page pertaining to them will show.



Flush Floor Transfer Table, with Incline Approaches

Above illustration shows table 10 feet long for single truck car. For double truck car the same style of table is made 22 feet long. Illustration shows hand moving gear, but, if desired, electric motor can be attached.



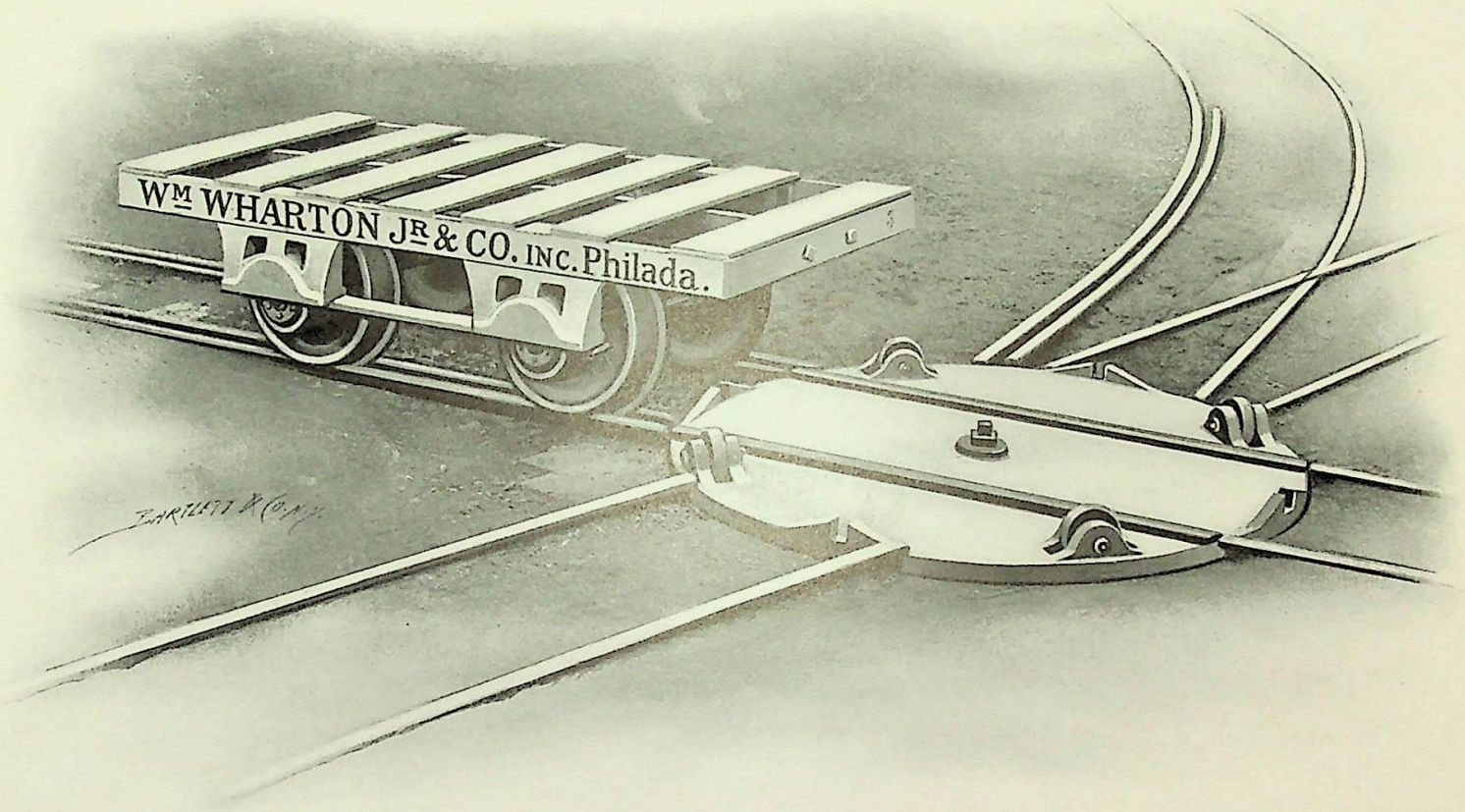
Turntable for Street Railways

Self-oiling center of hardened steel, with vertical and central adjustments. Made 10 feet 4 inches, 9 feet 4 inches, 8 feet 4 inches and 5 feet 4 inches diameter.

Industrial and Shop Railways and Trucks and Turntables for Same

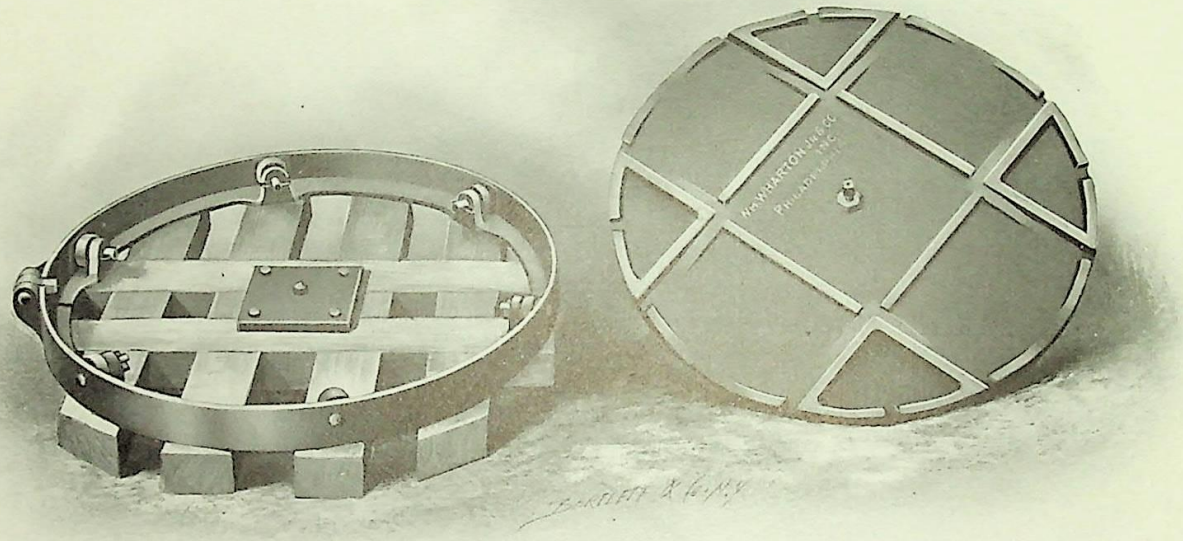
WE furnish curves, switches, frogs, crossings and turntables for industrial railways and railways in shops, for any weight of rail, and for either portable or permanent track. Designs submitted upon application, and correspondence on this subject solicited.

We have special facilities and experience in building light, easy running trucks for shop railways, and the following pages illustrate some of our work in this line.



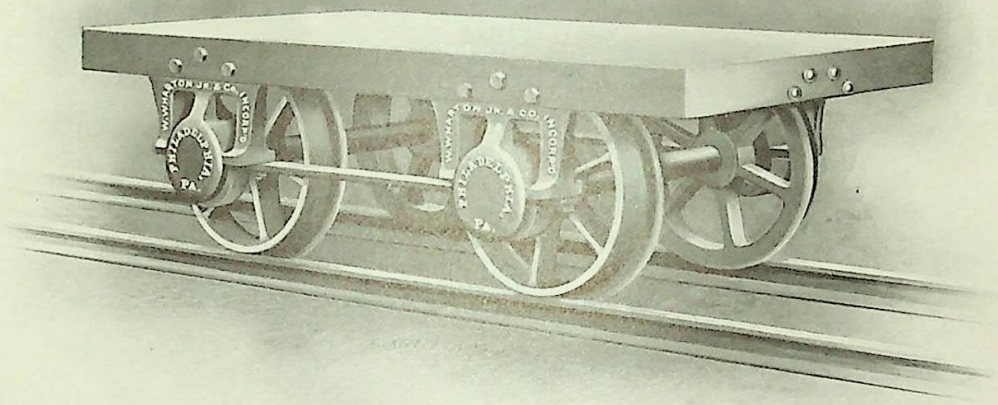
Truck with Solid Wrought-iron Frame
and Anti-friction Roller Bearings

Plate Turntable
with Exposed Wheels



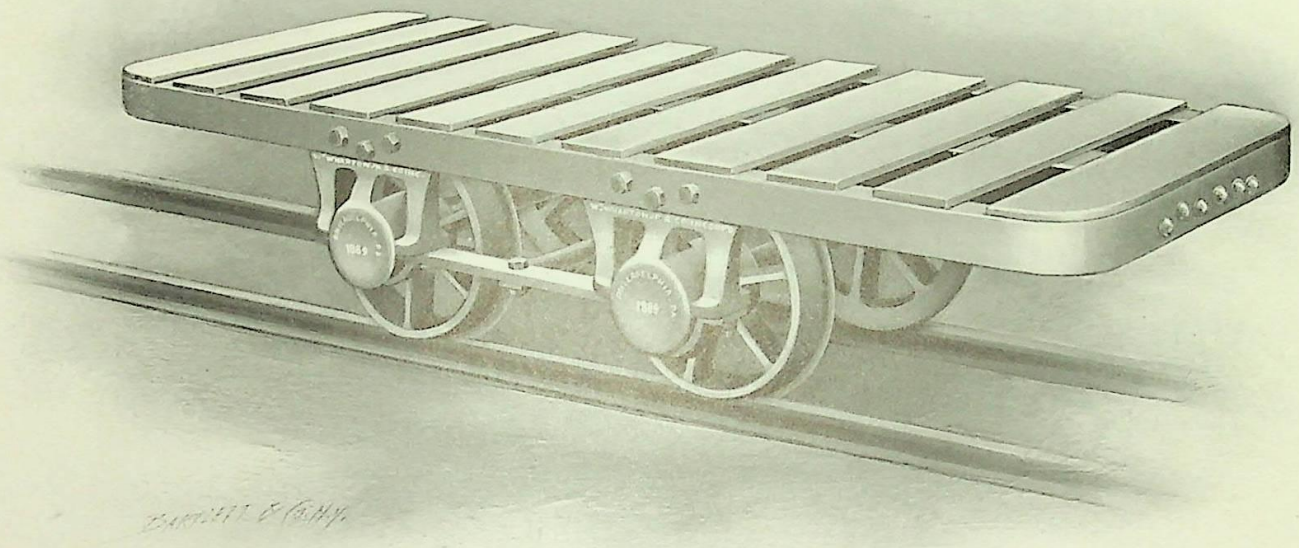
Rim Turntable

Adapted to shop, yard or mine use. Rim 4 feet 3 inches diameter, 4¾ inches deep.



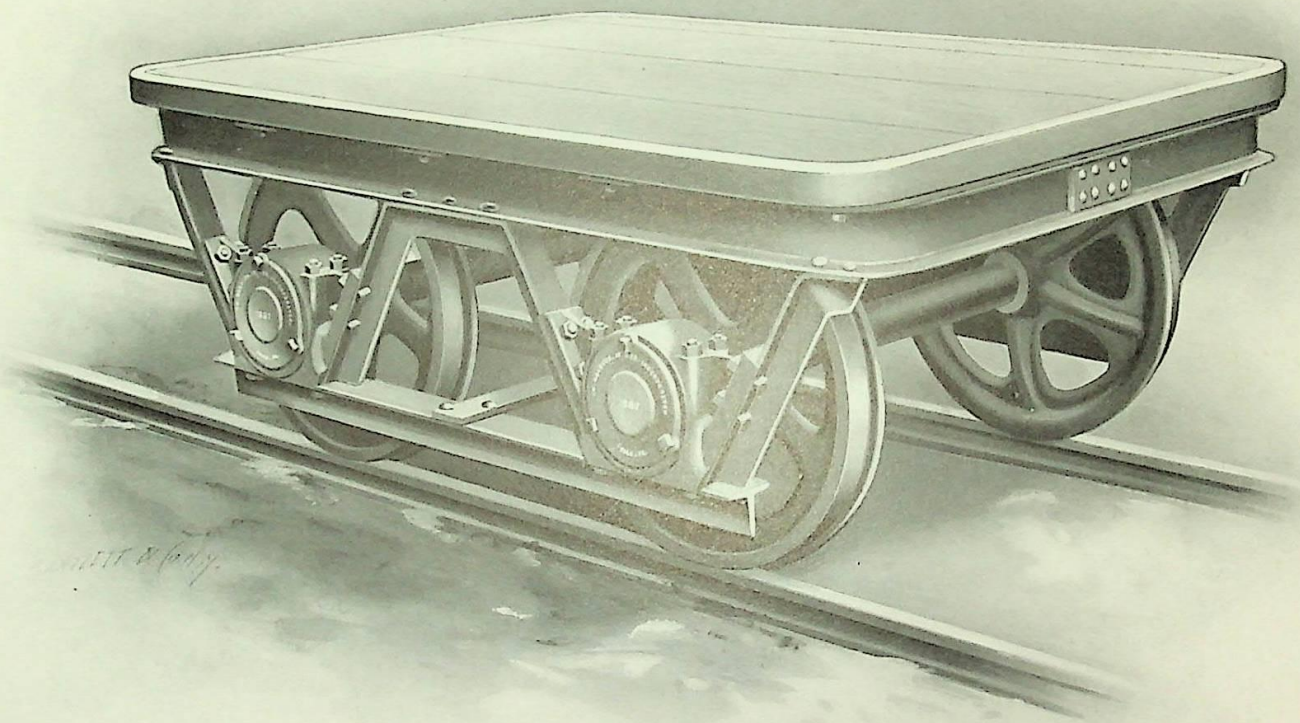
Standard Wrought-iron Frame Truck

20-inch Gauge. Anti-friction Roller Bearing



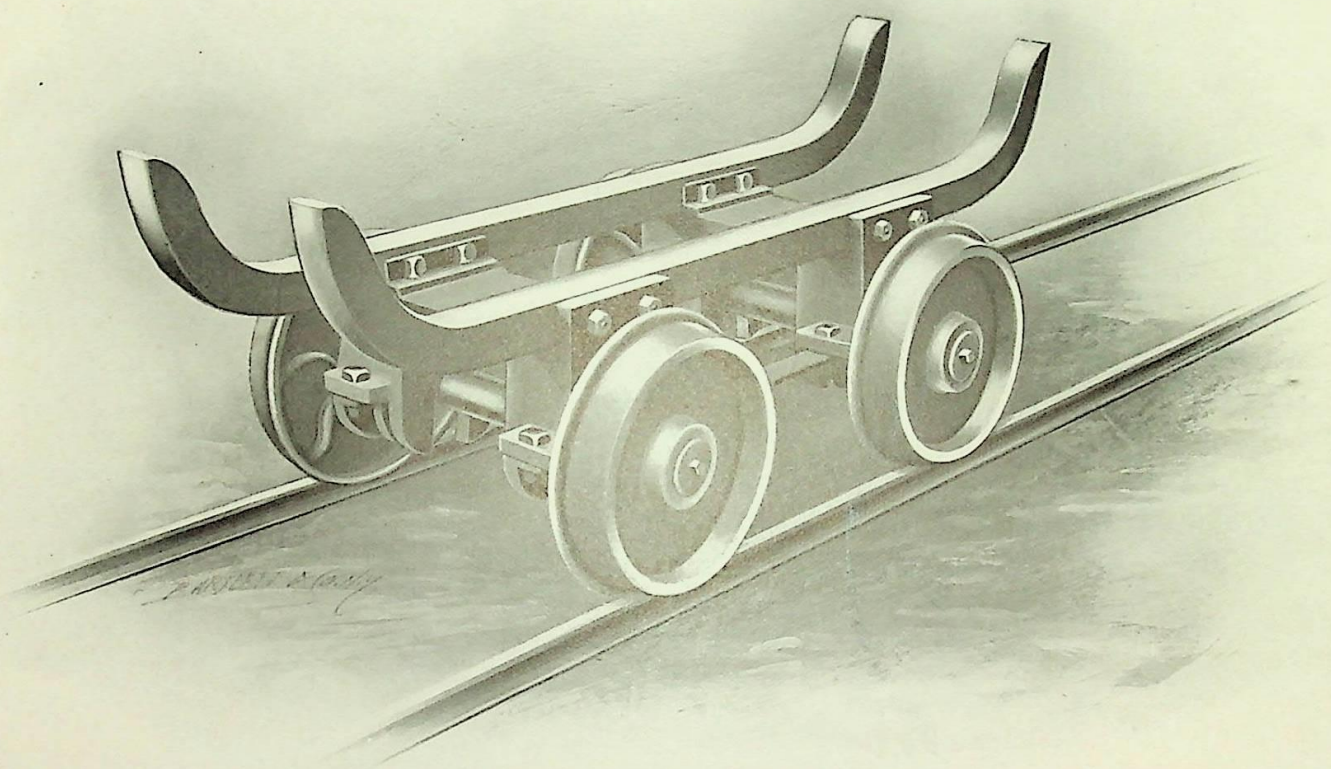
Extra Long Truck with Gridiron Top

Capacity about 3 Tons. Built for John A. Roebling's Sons Co. Anti-friction Roller Bearings



Trucks, 5 Tons Capacity

With Wooden Top and Anti-friction Roller Bearings. Built for Armington & Sims Engine Company



Pig-iron Truck

With Anti-friction Roller Bearings. Capacity 5 Tons

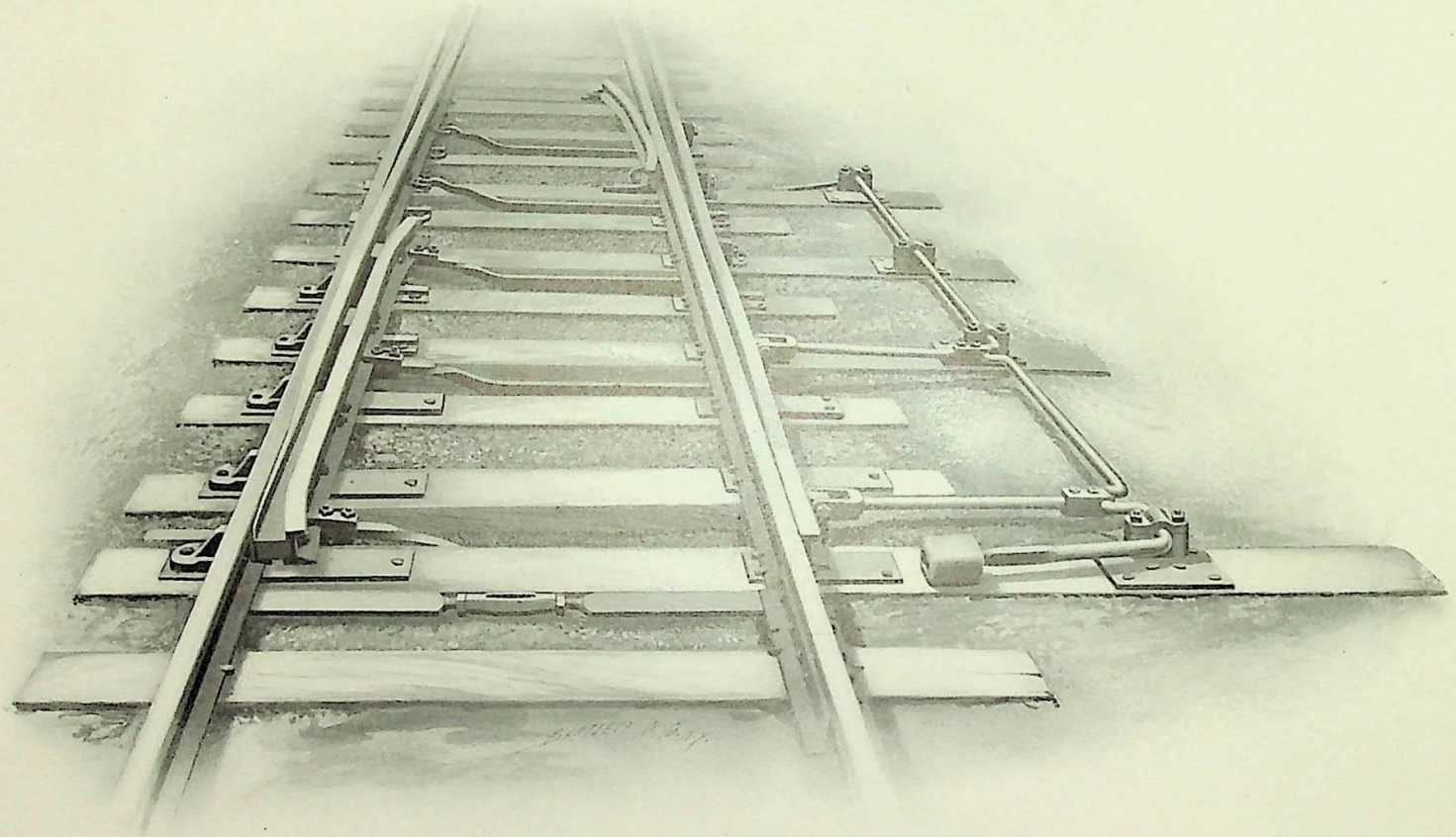
Steam Railroad Special Track Work

Steam Railroad Switch Works, Jenkintown, Pa.

Wharton Improved Railroad Switch, Main Line Unbroken

Switch Set for Siding

Patented April 2, 1901

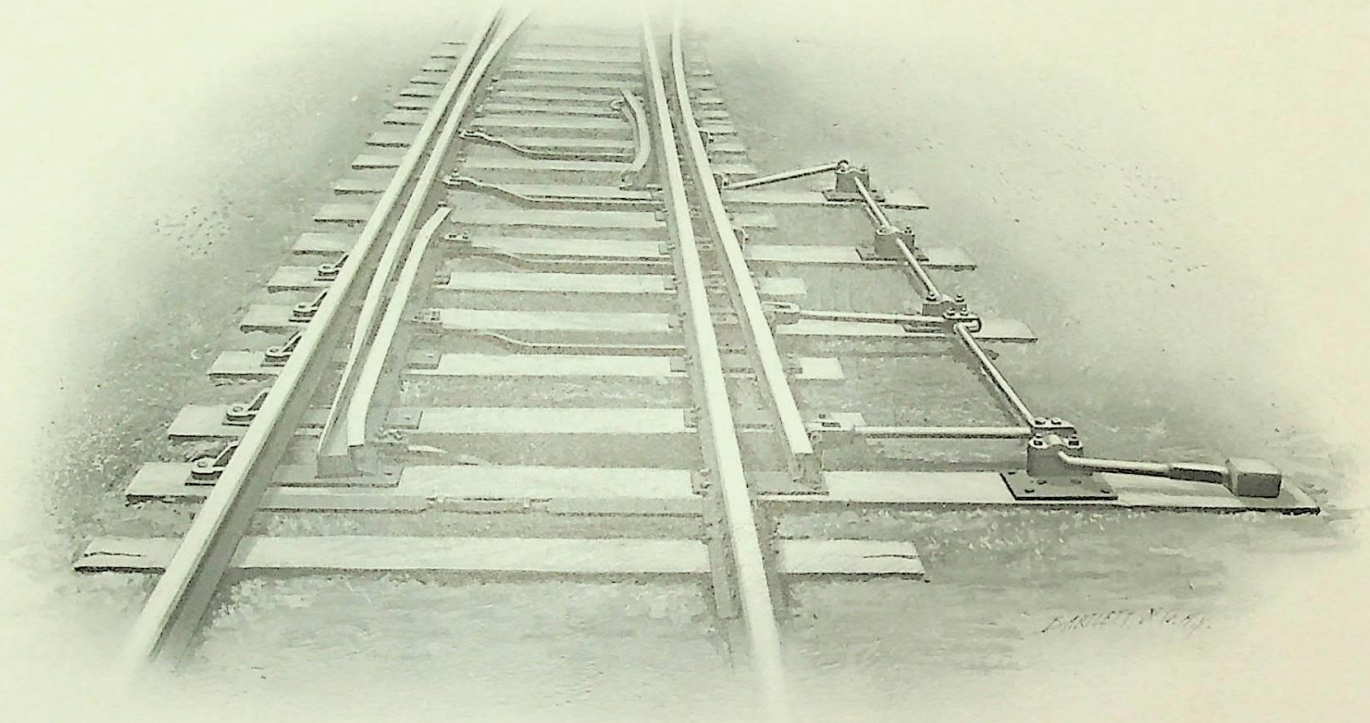


The overhanging portion of the car wheel tread rides up on the inclined elevating rail, placed outside of the main rail (on right-hand side of the above illustration), lifting the wheel so that its flange will pass over the head of the main rail without touching it, while the point rail on the other side guides the train onto the siding. A train coming heel on, on the main track, when the switch is set for the siding, moves the trip rail, and by a crank motion automatically throws the switch rails over into the open position.

Wharton Improved Railroad Switch, Main Line Unbroken

Switch Open for Main Line

Patented April 2, 1901

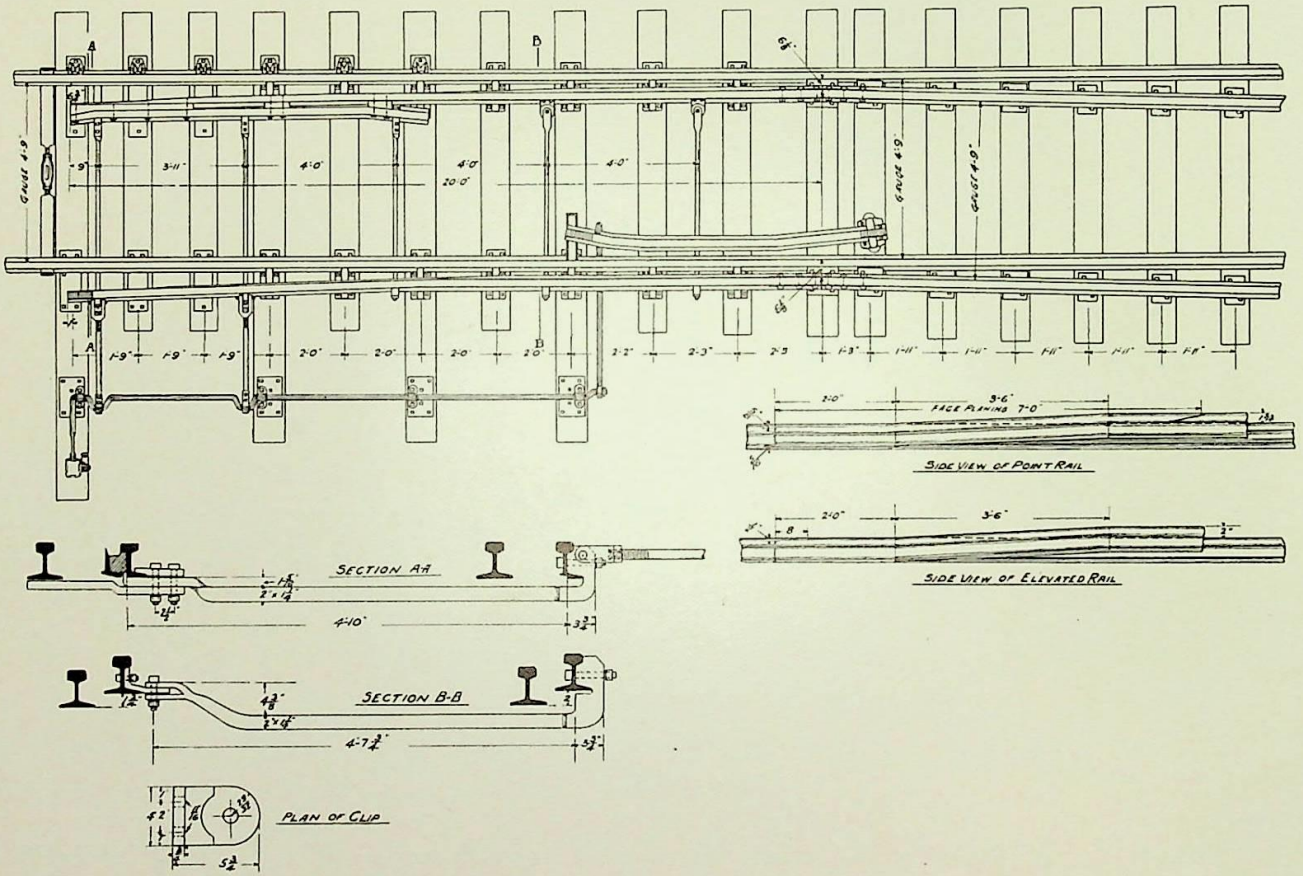


The main track is entirely continuous and clear of all obstructions, and the car wheels cannot strike any part of the switch. For general dimensions see following pages. Built for any weight of rail.

Wharton Improved Railroad Switch, Main Line Unbroken

Switch Open for Main Line

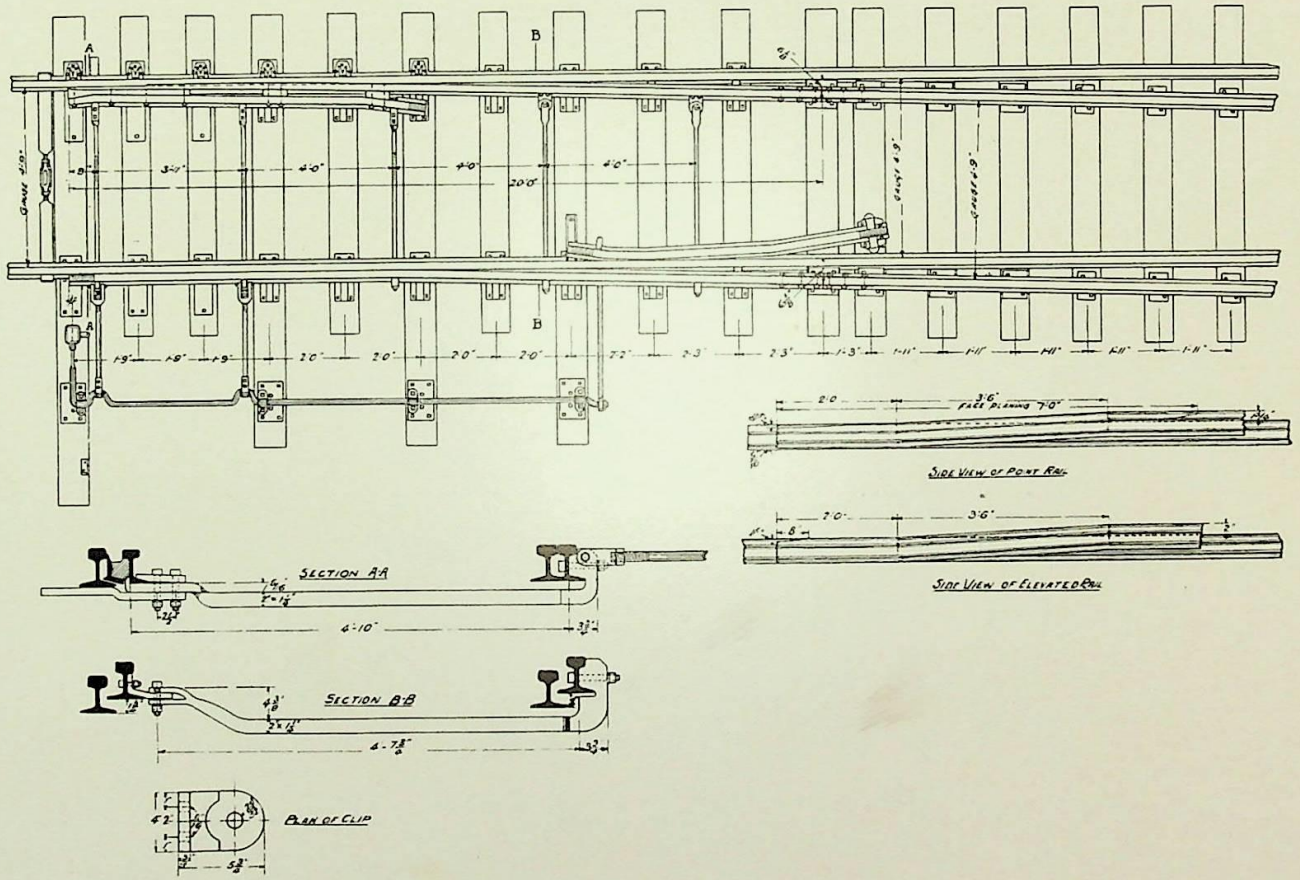
Patented April 2, 1901



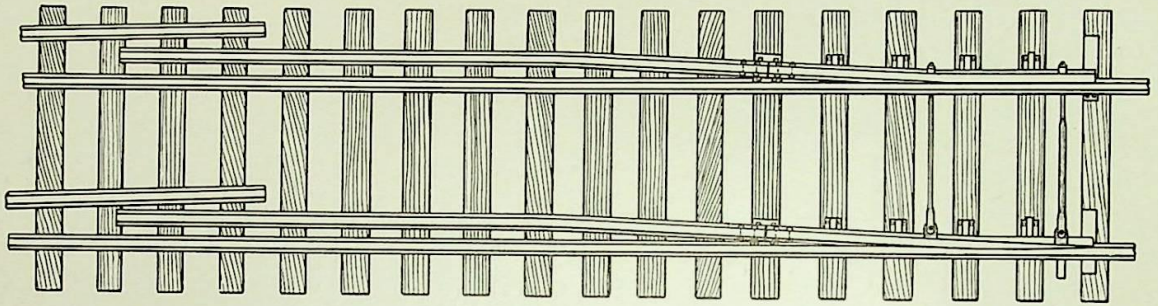
Wharton Improved Railroad Switch, Main Line Unbroken

Switch Set for Siding

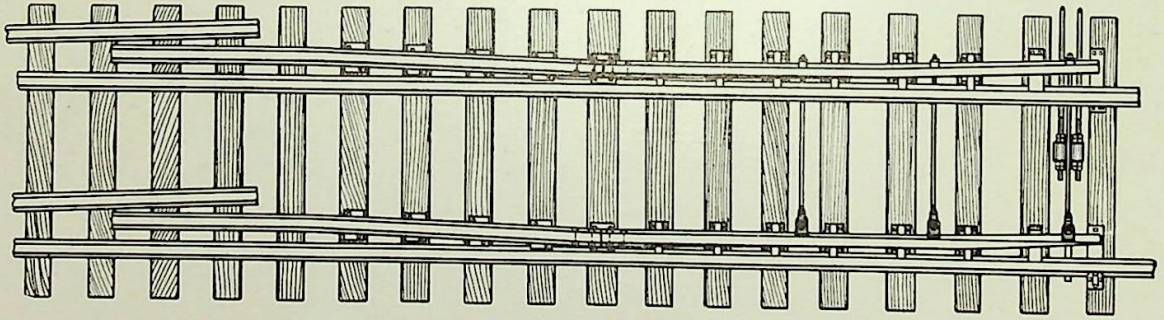
Patented April 2, 1901



Wharton Throw-off

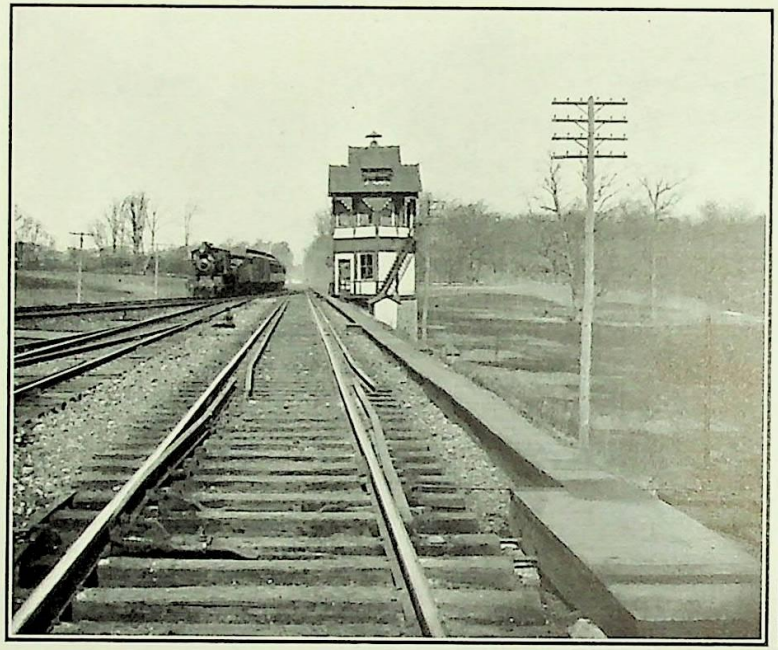


10-foot Throw-off, Closed

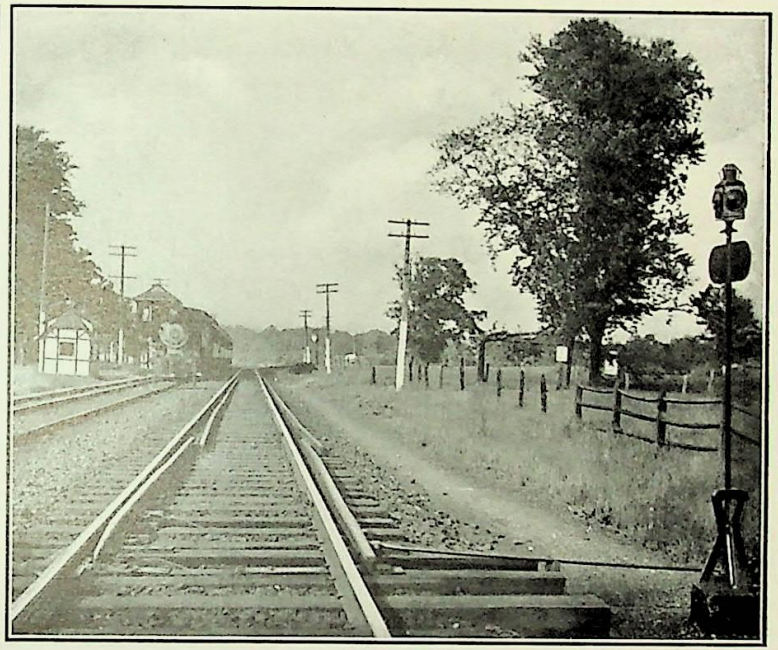


15-foot Throw-off with interlocking Rod, Open

Wharton Throw-off or Derailer in Service



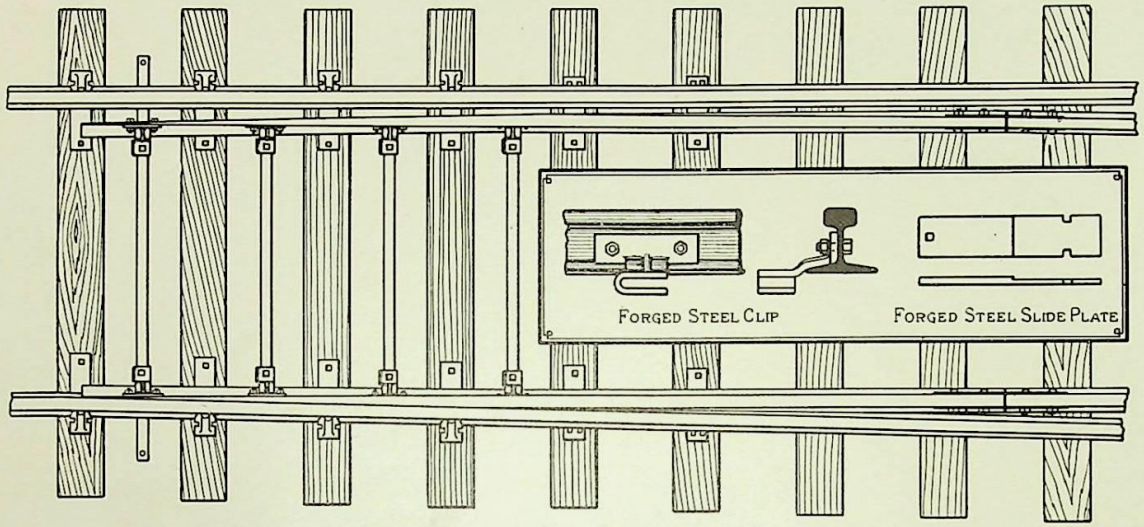
Set for Derailing



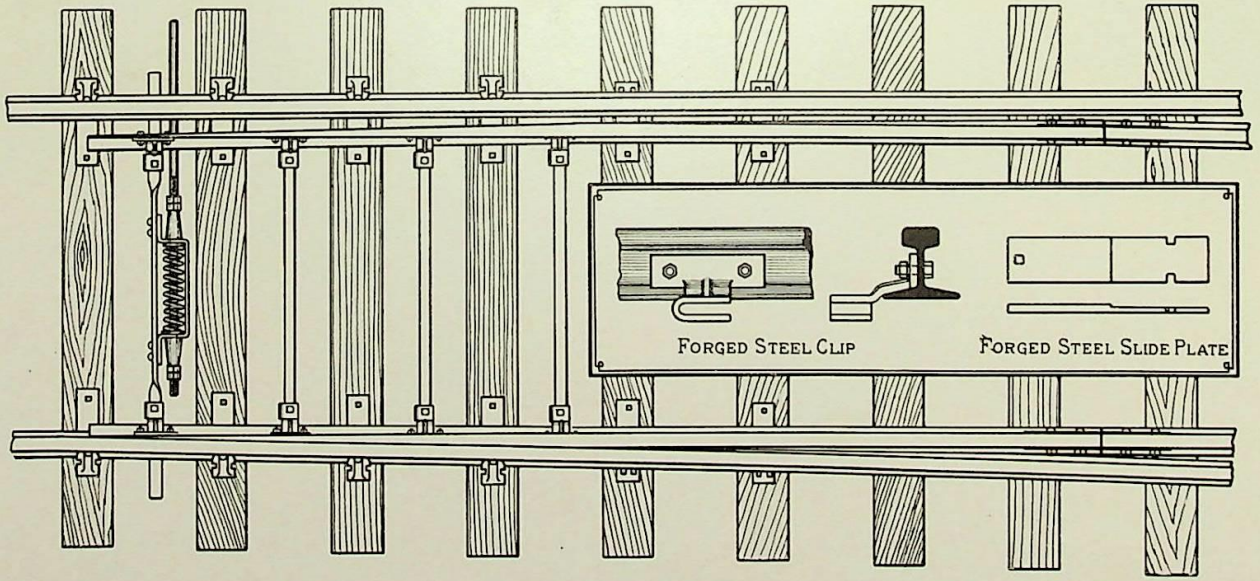
Set for Clear track

Constructed on the same principle as the unbroken main line switch (see page 94). Traffic on "clear" track touches no part of the derailer.

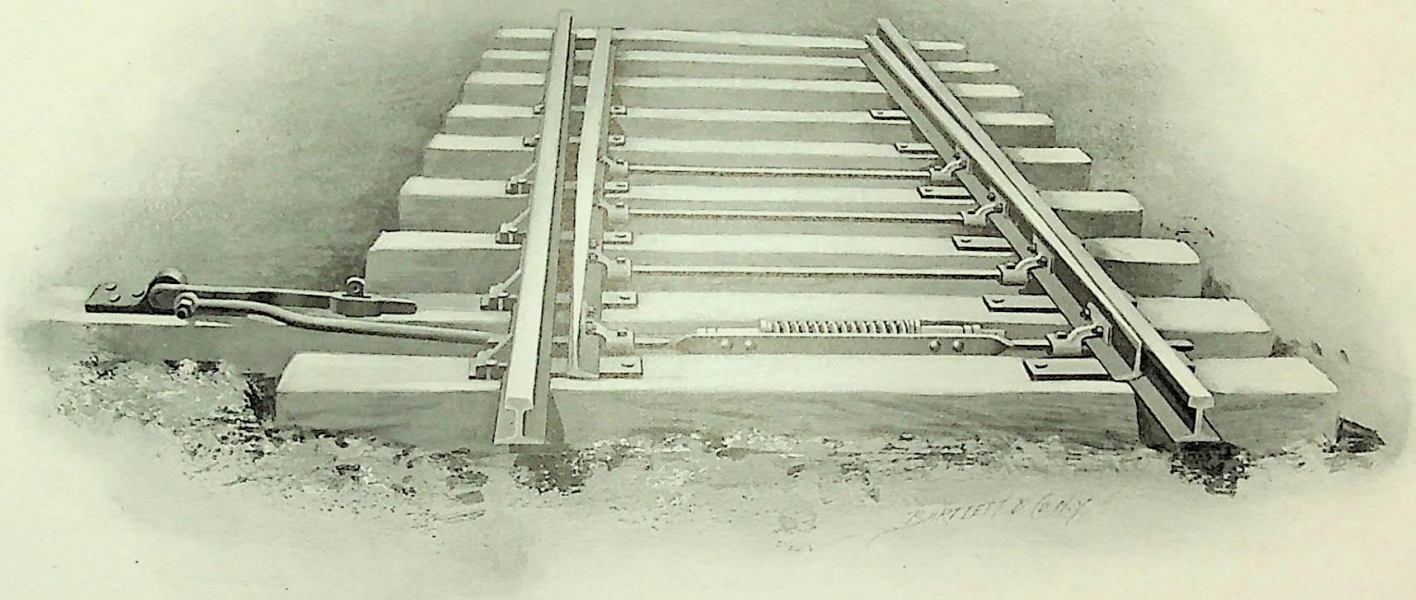
Stiff Split Switch



Spring Split Switch



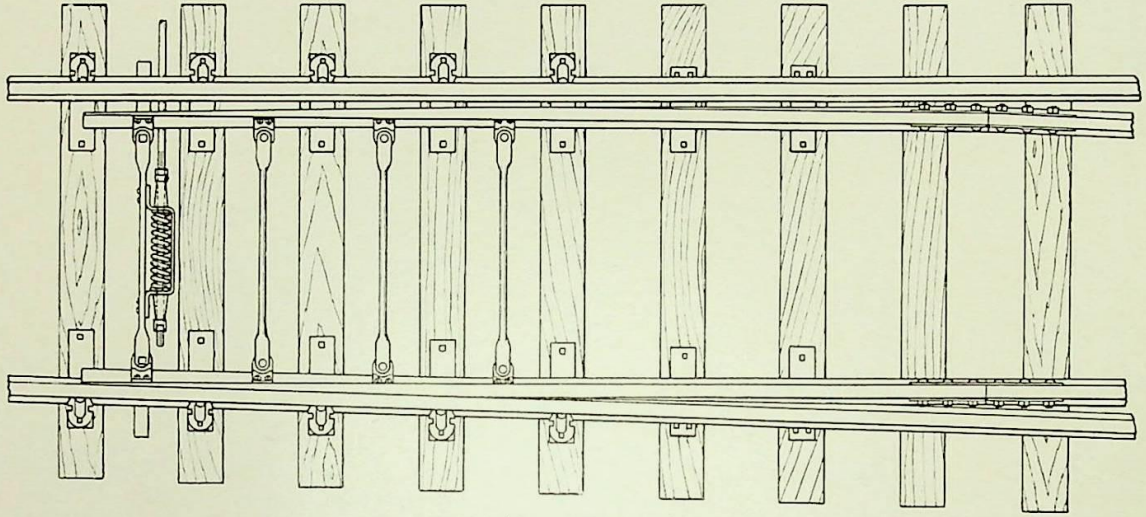
Spring Split Switch



Forged steel clips. Forged steel slide plates. Made stiff or spring connected as desired.

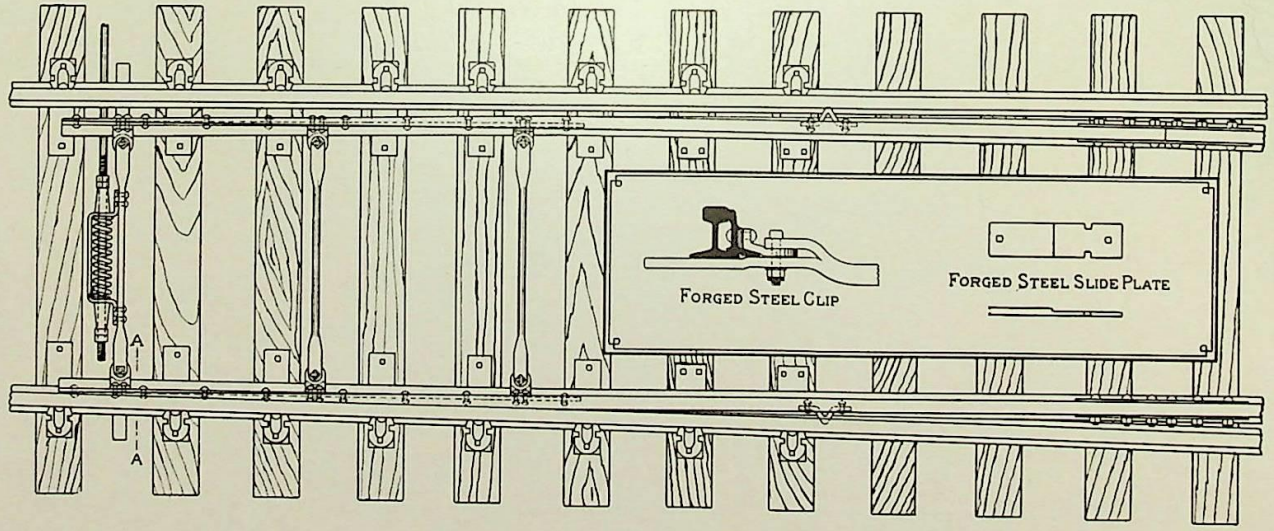
Split Switch

Four Tie Bar Pattern



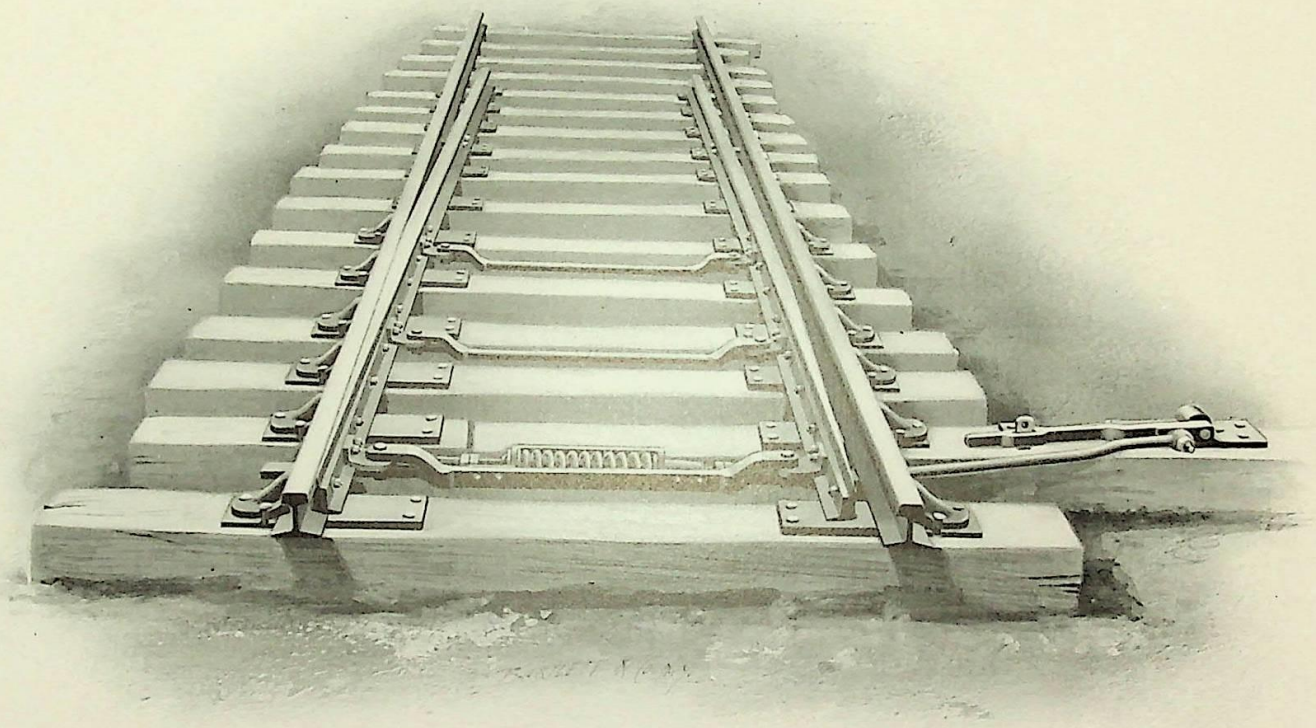
Split Switch

Three Tie Bar Pattern with Reinforcement Straps



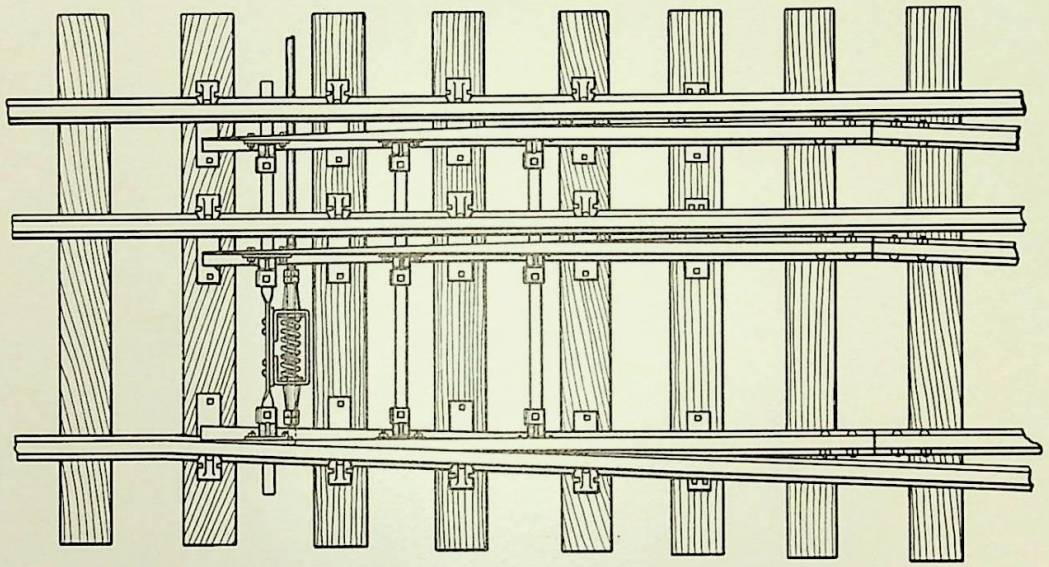
Split Switch

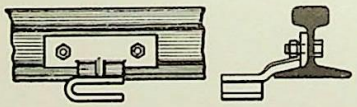
Three Tie Bar Pattern



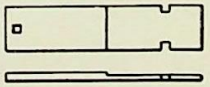
Reinforcement straps. Forged steel clips. Forged tie bars. Forged steel slide plates.

Combination Split Switch for Wide and Narrow Gauges



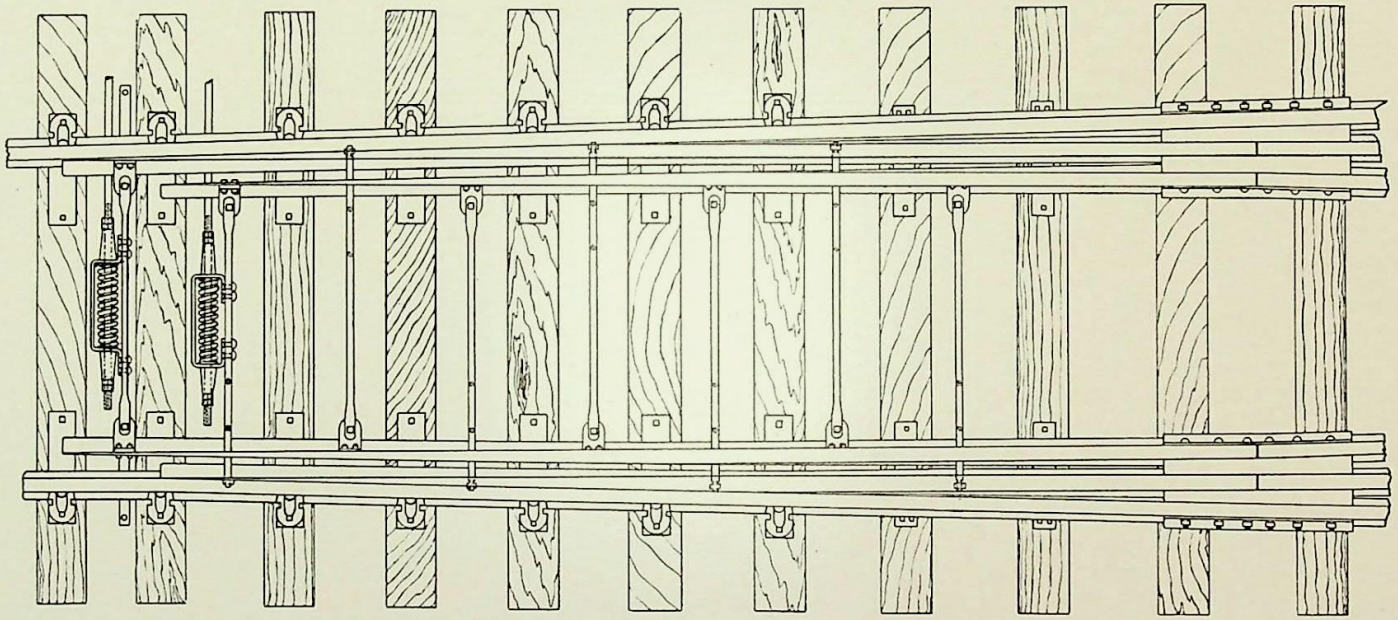


FORGED STEEL CLIP

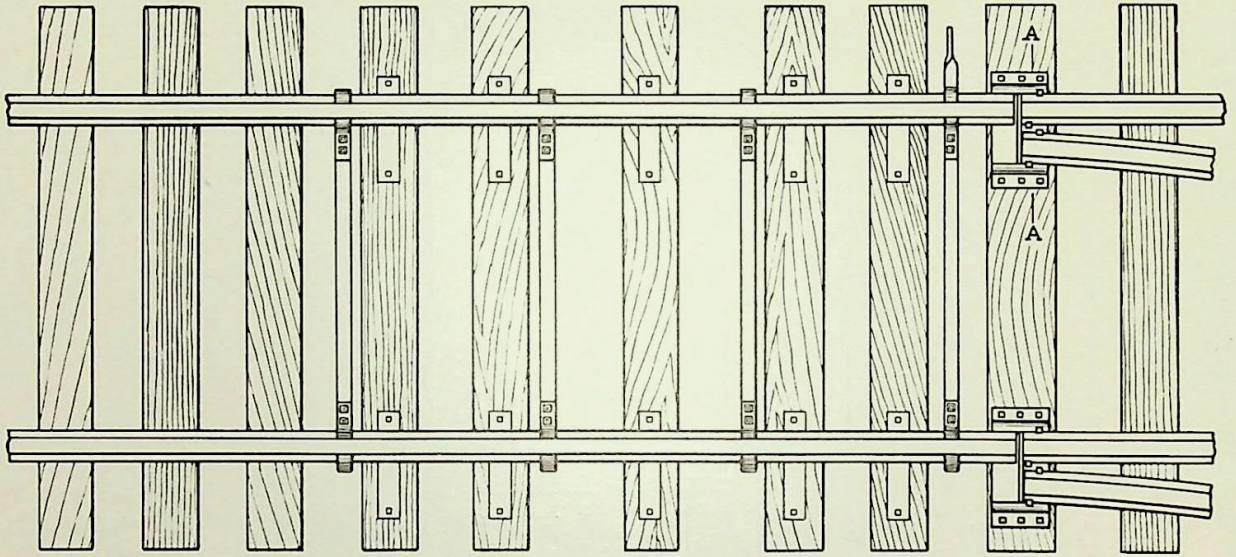


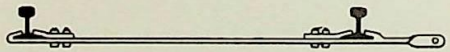
FORGED STEEL SLIDE PLATE

Three-throw Split Switch



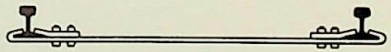
Stub Switch





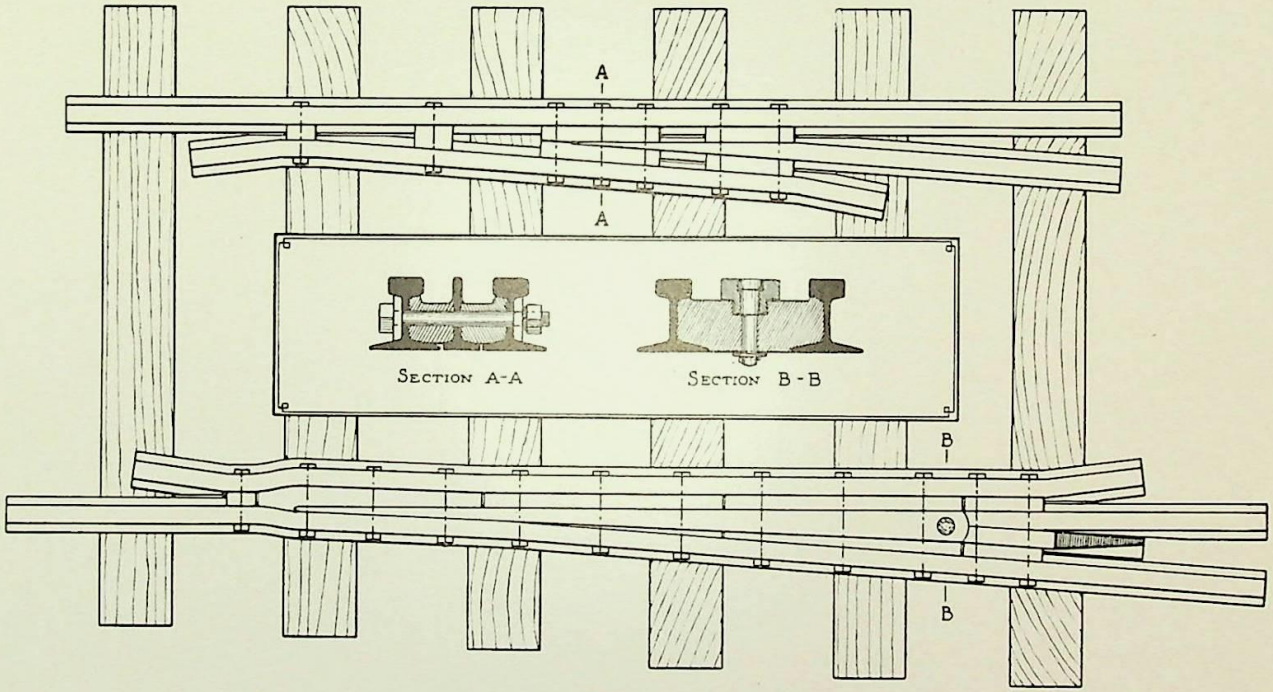
FRONT ROD

SECTION A–A



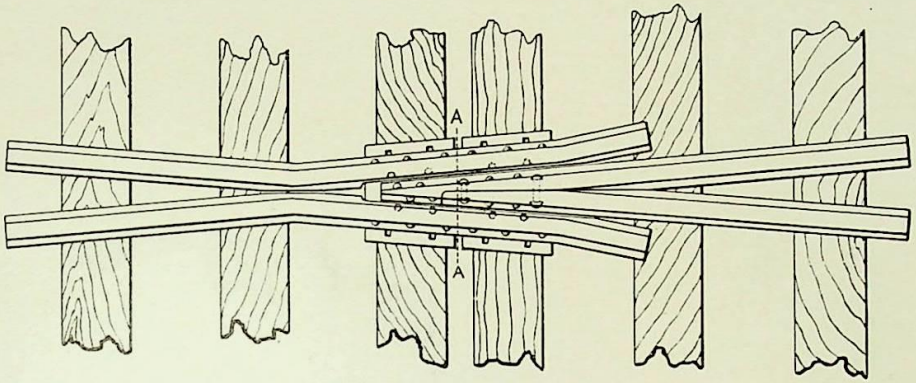
BACK RODS

Tongue Switch and Mate



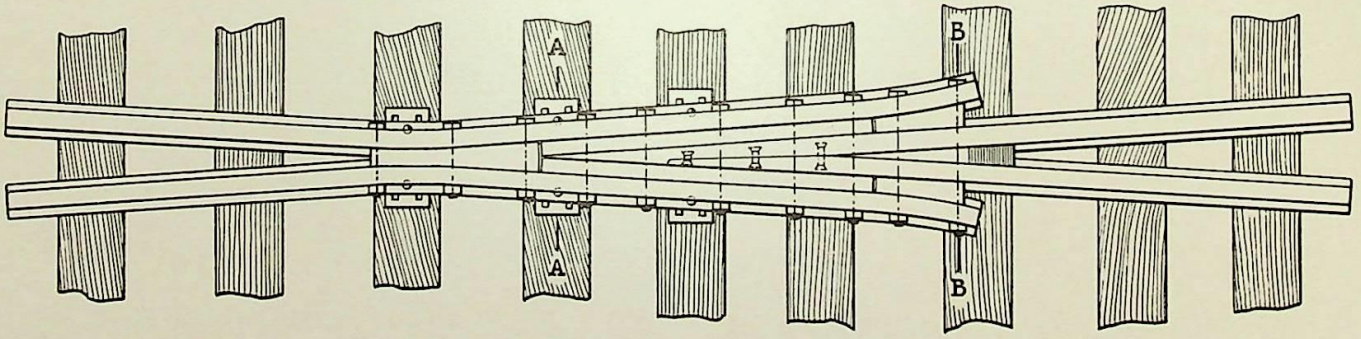
Riveted Plate Frog

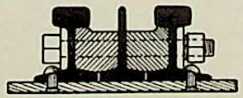
SECTION A-A



Filled and Bolted Frog

P. & R. Railway Standard

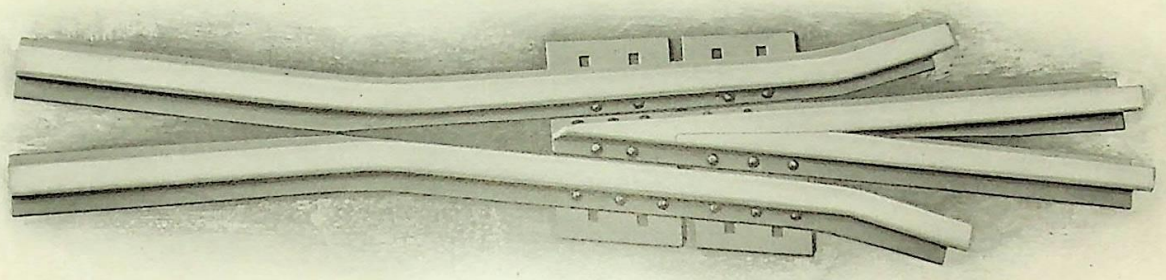




SECTION A-A

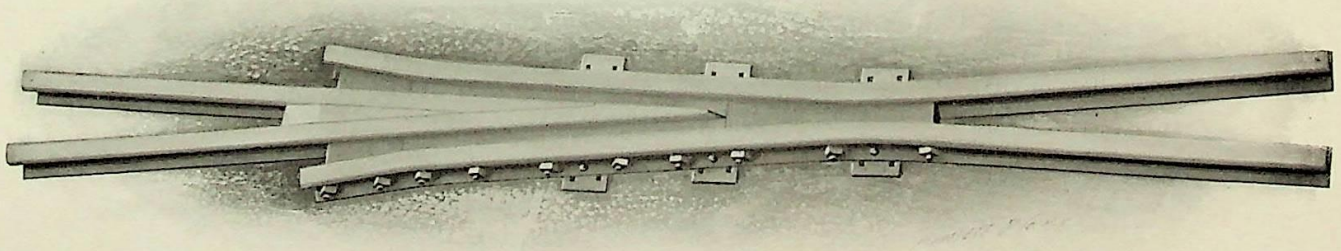
SECTION B-B

Riveted Plate Frog

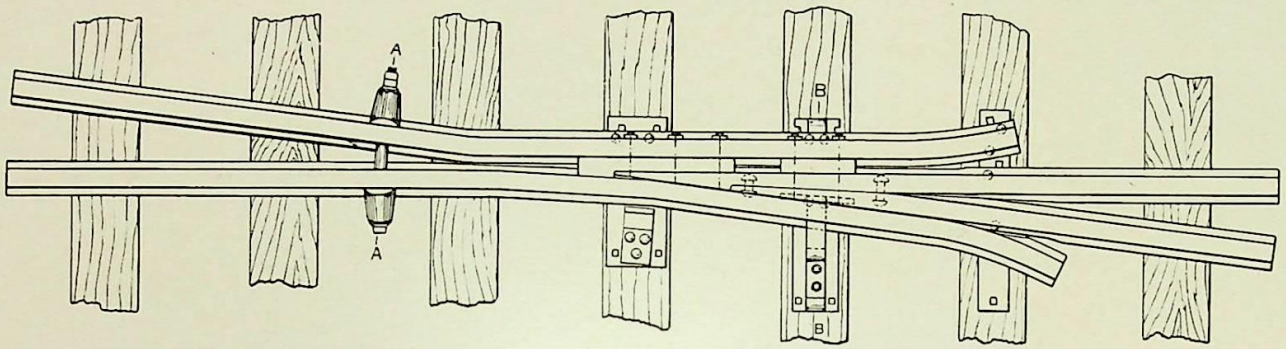


Filled and Bolted Frog

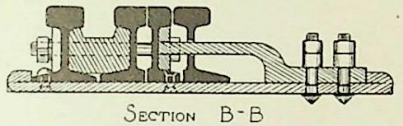
P. & R. Railway Standard



Spring Rail Frog for Light Traffic



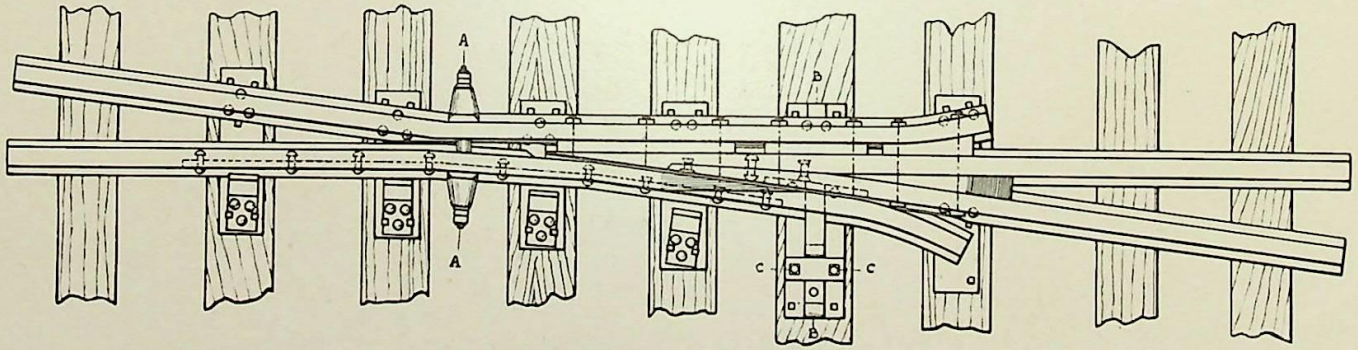
SECTION A-A



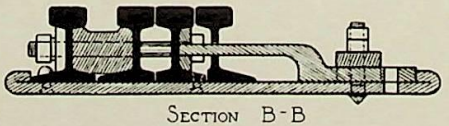
SECTION B-B

Spring Rail Frog with Slide Plates and Reinforced Wing Rail

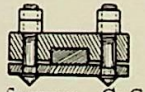
P. & R. Railway Standard



SECTION A-A

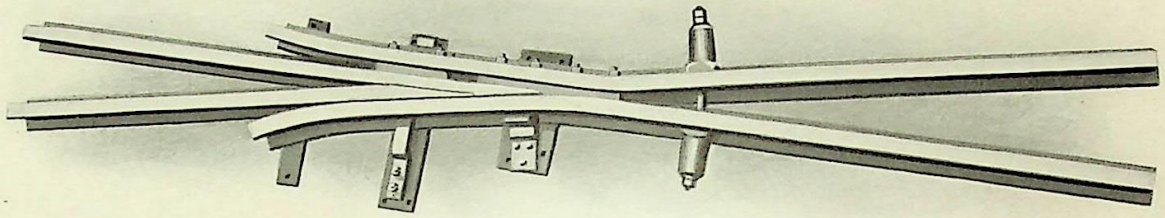


SECTION B-B



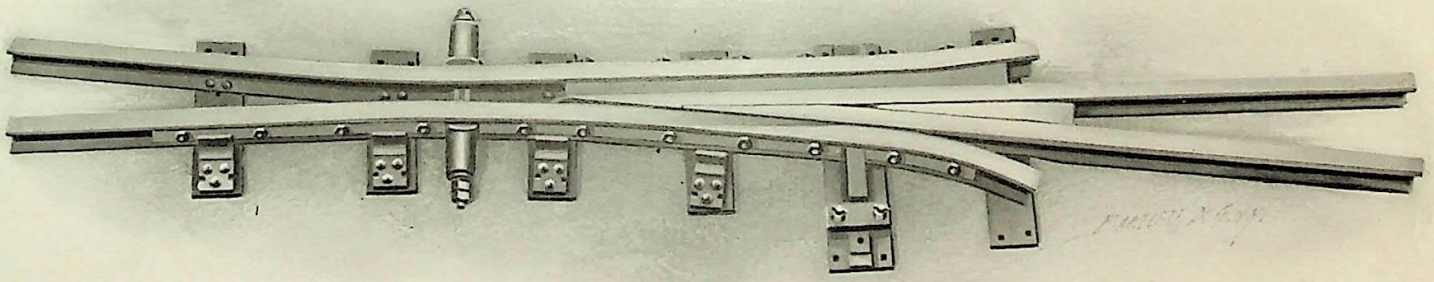
SECTION C-C

Spring Rail Frog for Light Traffic

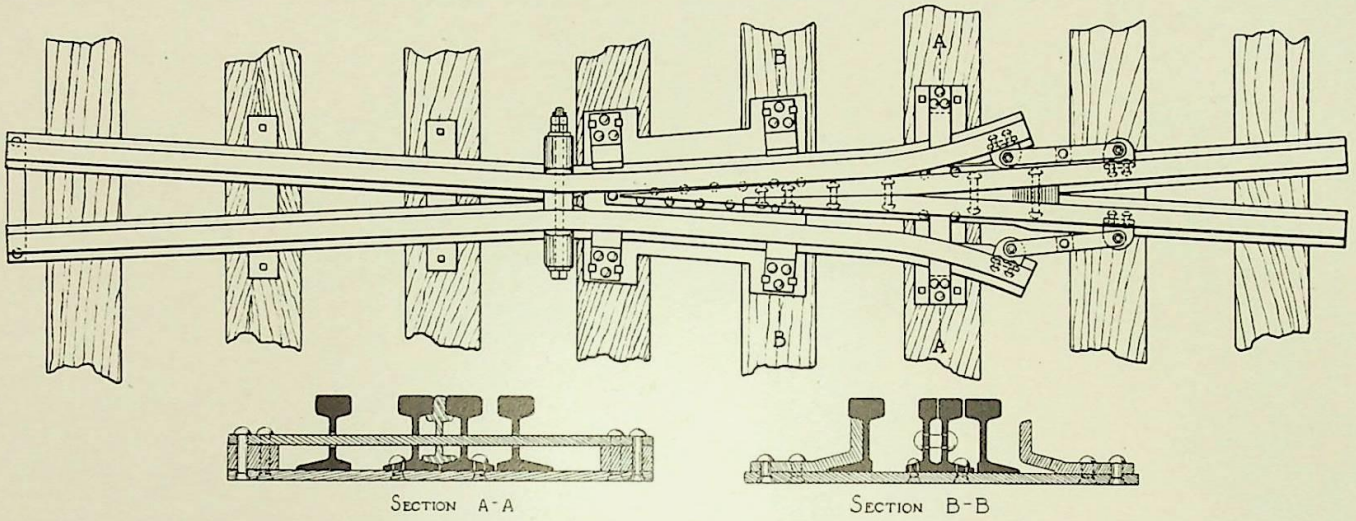


Spring Rail Frog with Slide Plates and Reinforced Wing Rail

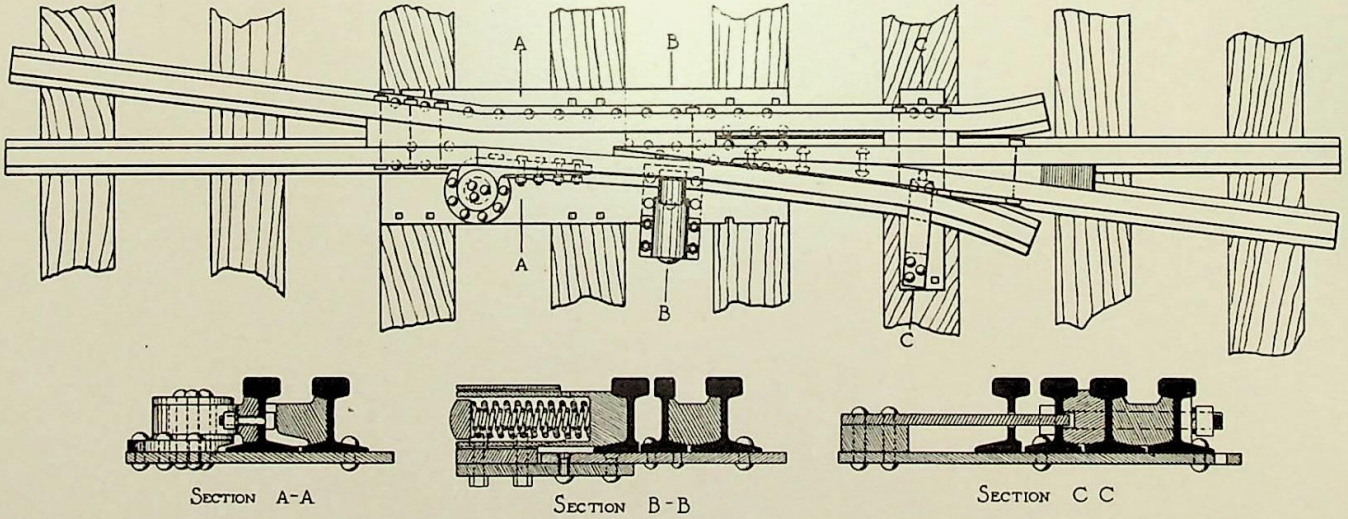
P. & R. Railway Standard



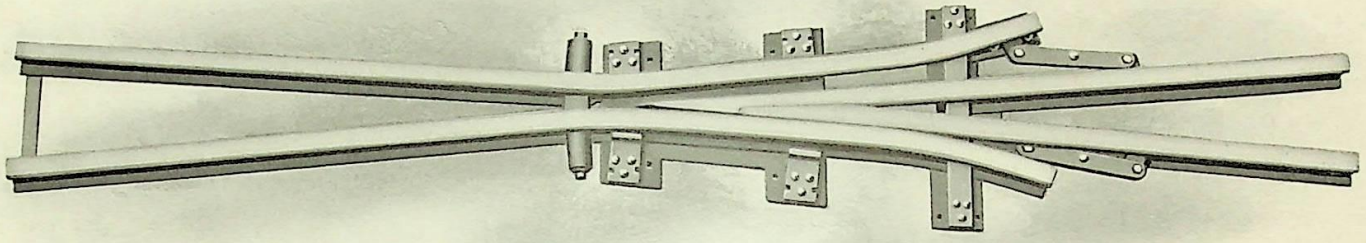
Vaughan's Patent Sliding Wing Frog



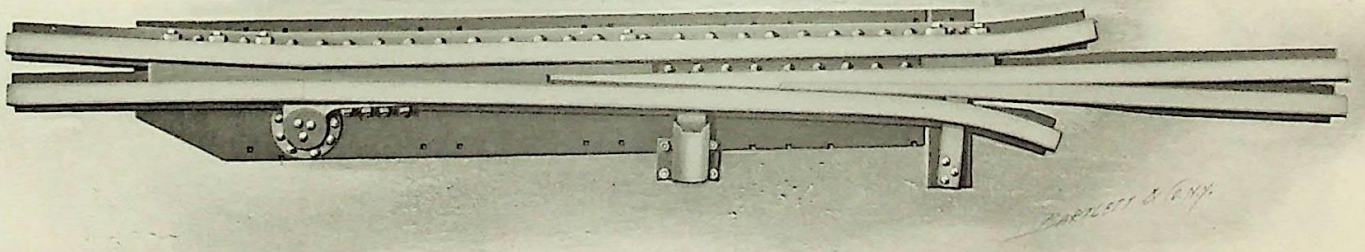
Vaughan's Patent Hinged Spring Frog



Vaughan's Patent Sliding Wing Frog

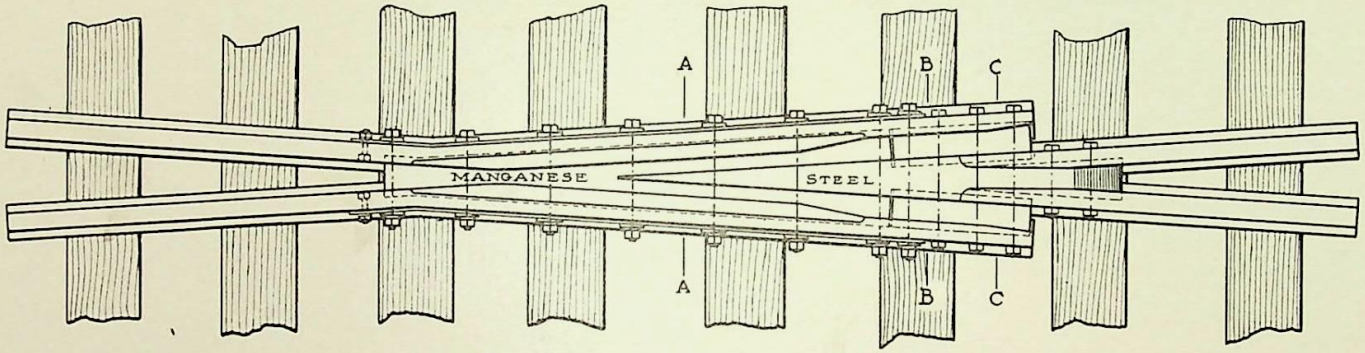


Vaughan's Patent Hinged Spring Frog

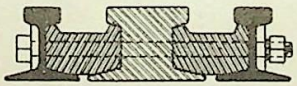


Manganese Steel Frog

Patented June 25, 1901 and September 17, 1901



SECTION A-A



SECTION B-B

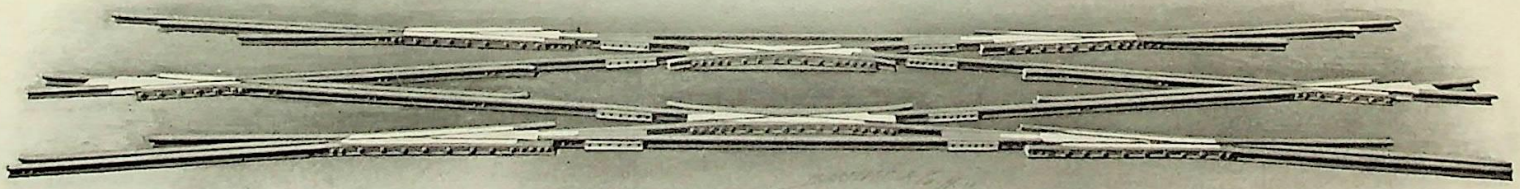
SECTION C-C

Manganese Steel Frog

Patented June 25, 1901 and September 17, 1901

These frogs are giving unprecedented length of life. Under all conditions of severe service, they have lasted many times longer than frogs made throughout of rails.

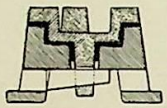
Scissor Crossing with Manganese Steel Frogs



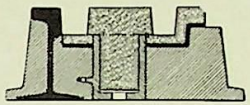
Tongue Switch, Mate and Frog, Manganese Steel Center Construction

For Steam Railroads in Paved Streets

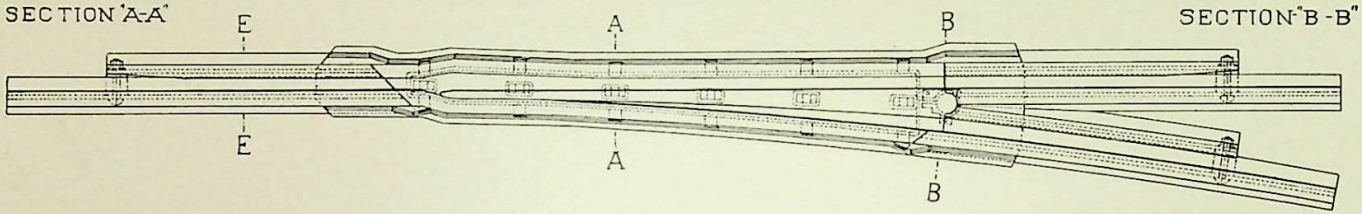
Patented May 16, 1893; June 5, 1894; September 3, 1895; December 10, 1895; July 20, 1897, and November 2, 1897



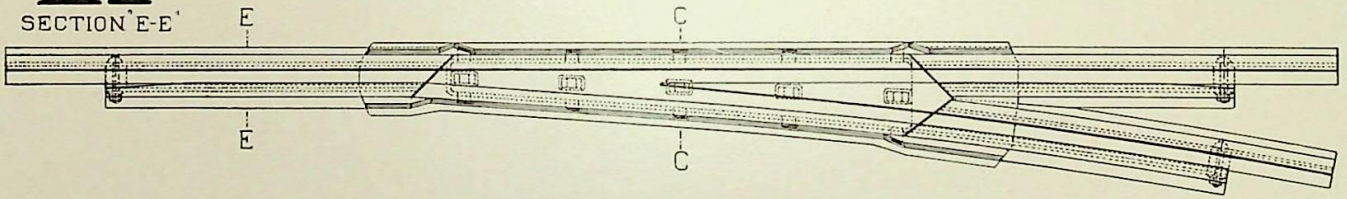
SECTION "A-A"

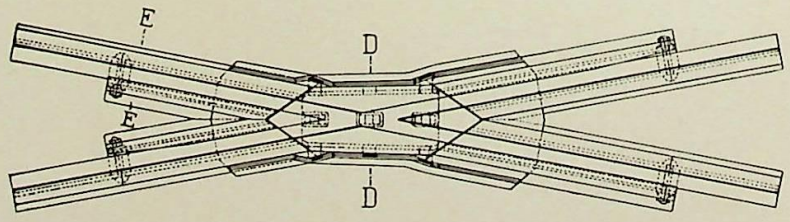


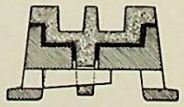
SECTION "B-B"



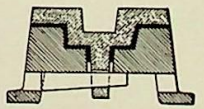
SECTION "E-E"







SECTION "C-C"

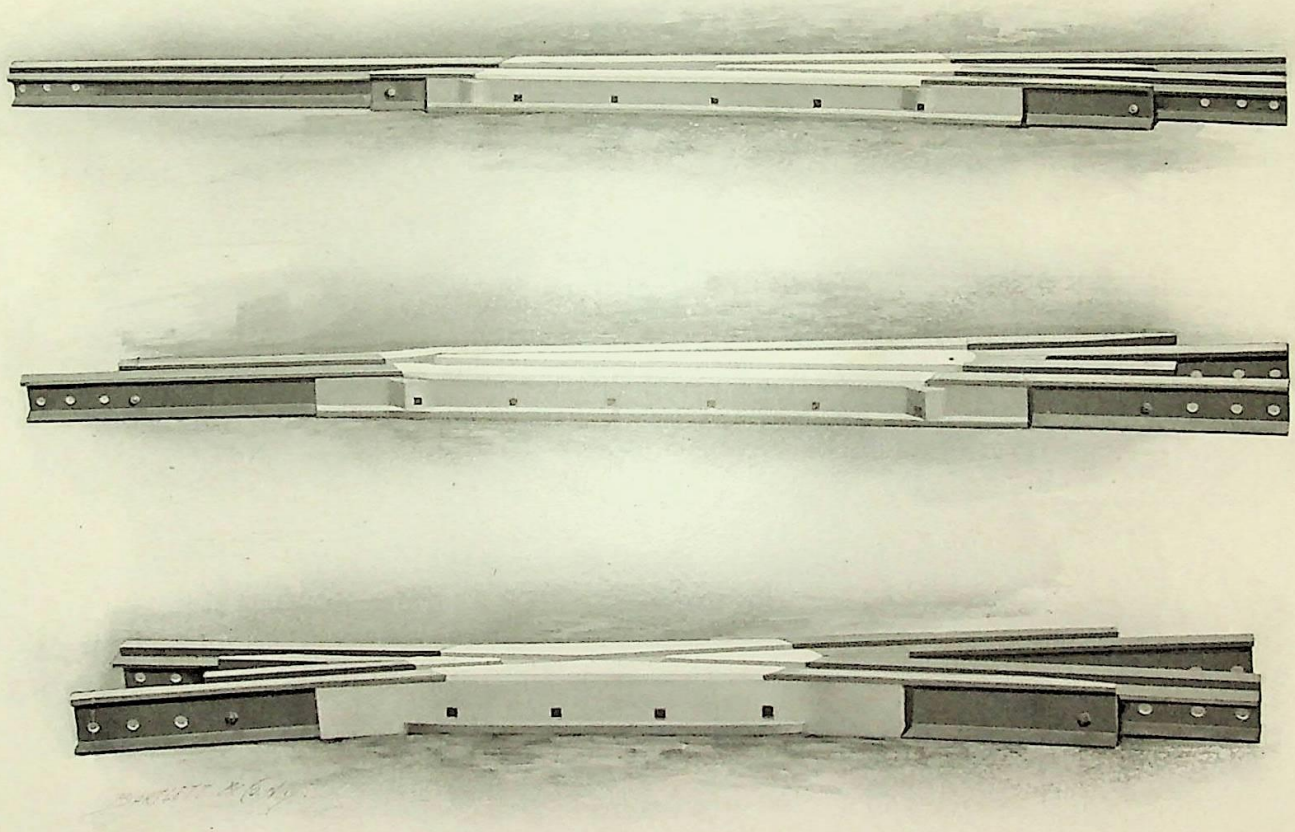


SECTION "D-D"

Tongue Switch, Mate and Frog, Manganese Steel Center Construction

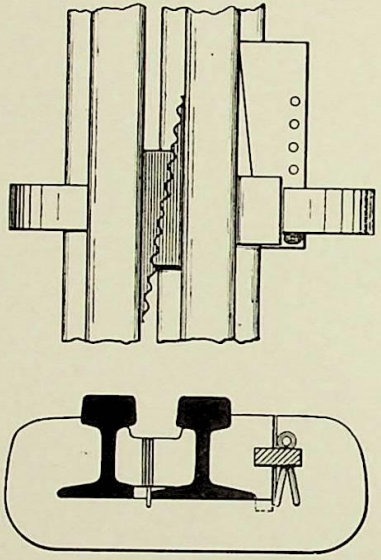
For Steam Railroads in Paved Streets

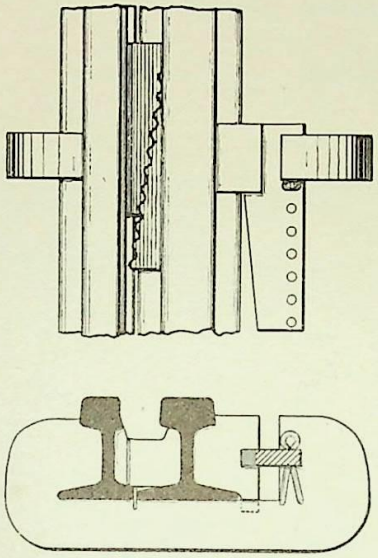
Patented May 16, 1893; June 5, 1894; September 3, 1895; December 10, 1895; July 20, 1897, and November 2, 1897

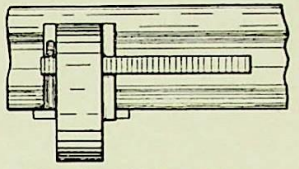


All wearing surfaces are either rolled steel or manganese steel, giving much longer life than either cast-steel or chilled iron switch pieces. Ends of pieces are formed of same rolled rail as in adjoining track, thereby allowing proper splicing.

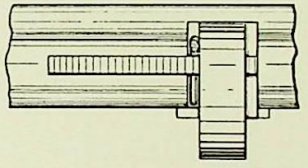
Forged Adjustable Guard Rail Clamp







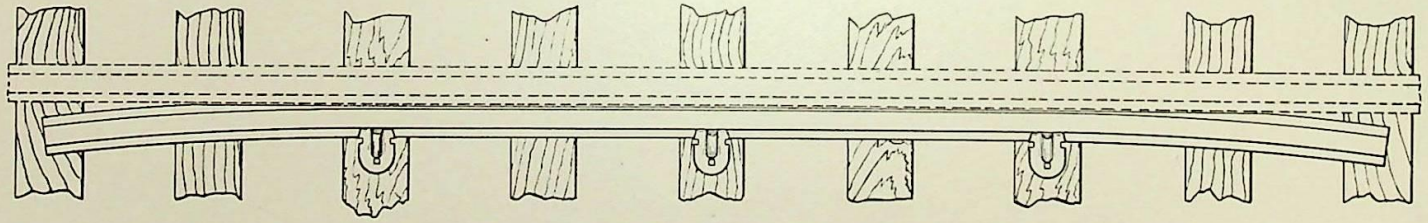
SIDE VIEW GUARD RAIL UNWORN



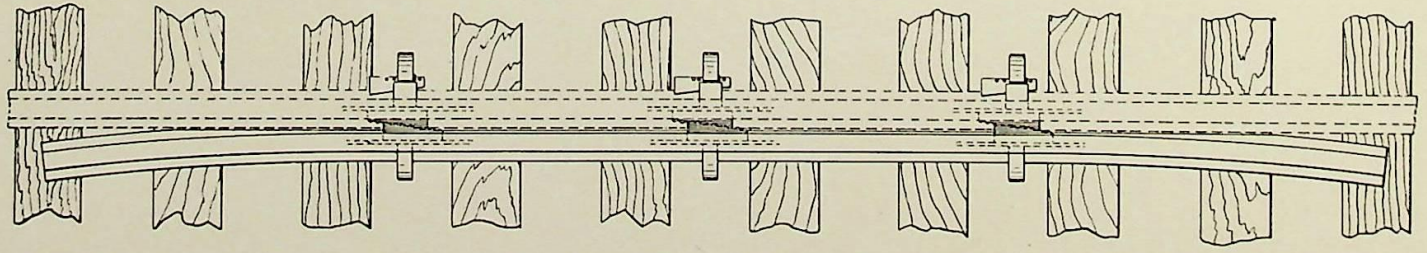
SIDE VIEW GUARD RAIL WORN

Guard Rails for Frogs

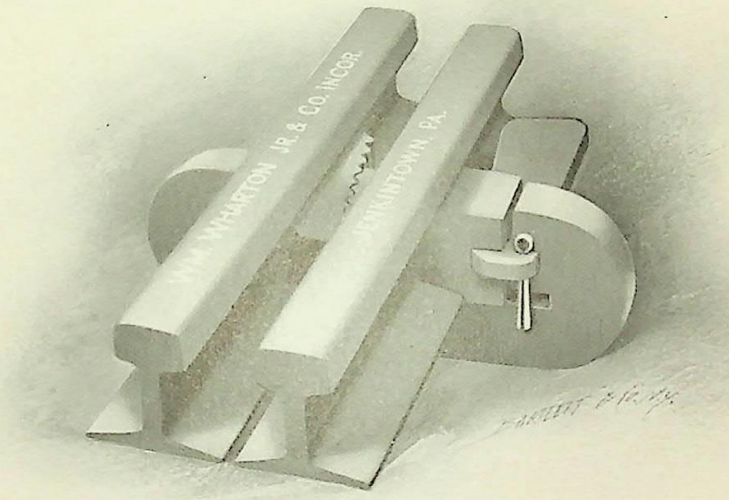
With Clamps



With Braces

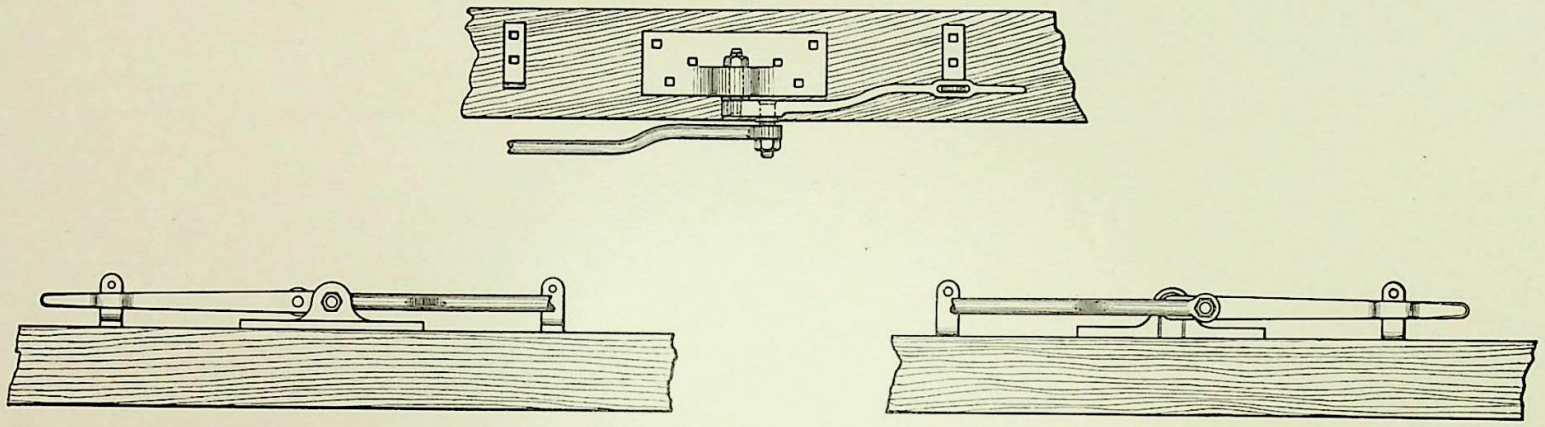


Forged Adjustable Guard Rail Clamp

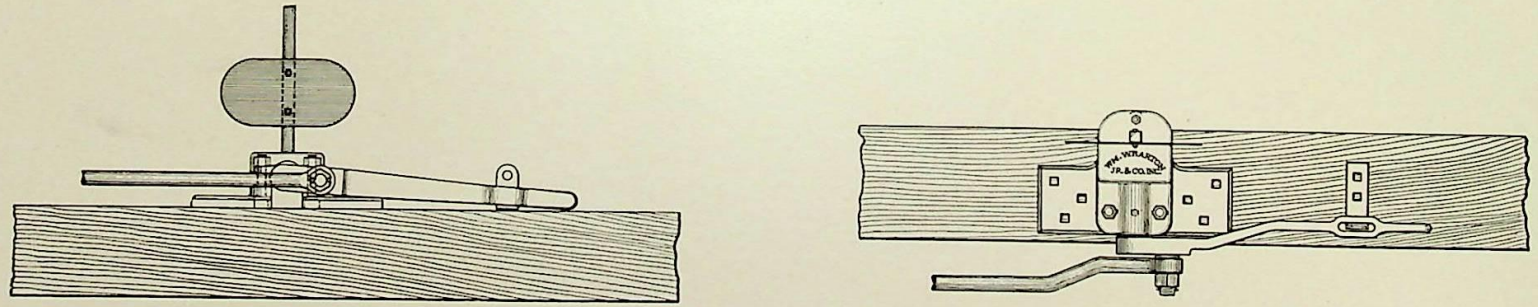


They hold guard rails more securely than bolts and braces. The yokes are heavy, solid, steel forgings, and will not bend or break. Adjustable to any width of throat by ratchet filler. Filler provided with keepers, preventing creeping of same past the clamping yoke.

Ground Throws for Switches

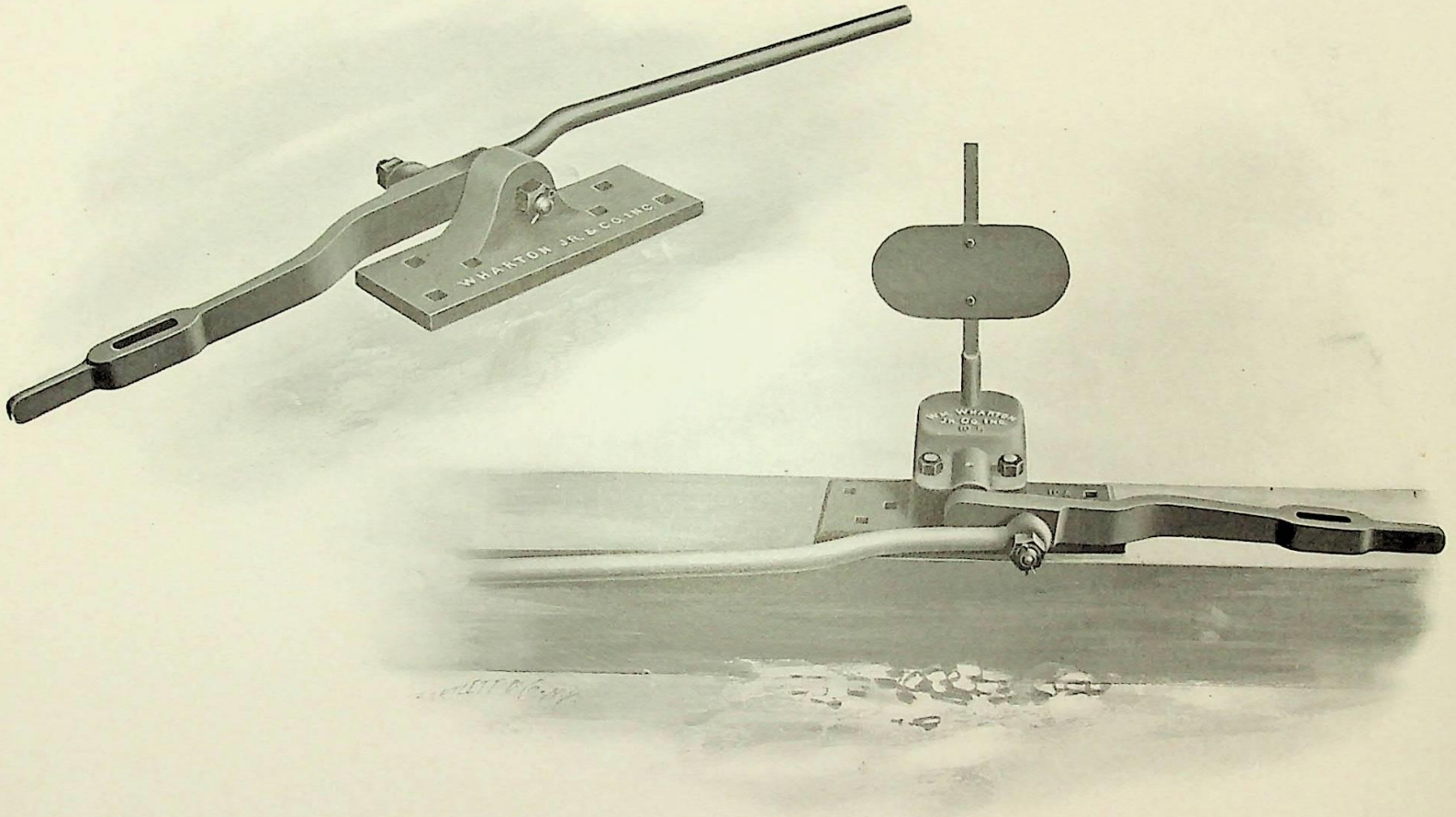


Plain Ground Throw with Forged Steel Lever



No. 10 Combination Ground Throw and Low Target, without Lamp

Ground Throws for Switches

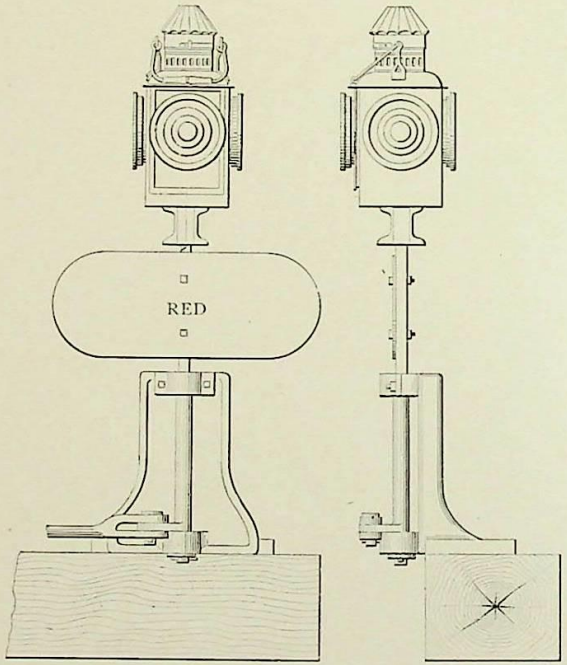


Plain Ground Throw with Forged Steel Lever

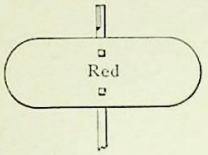
No. 10 Combination Ground Throw and Low Target, without Lamp

Same as page 123

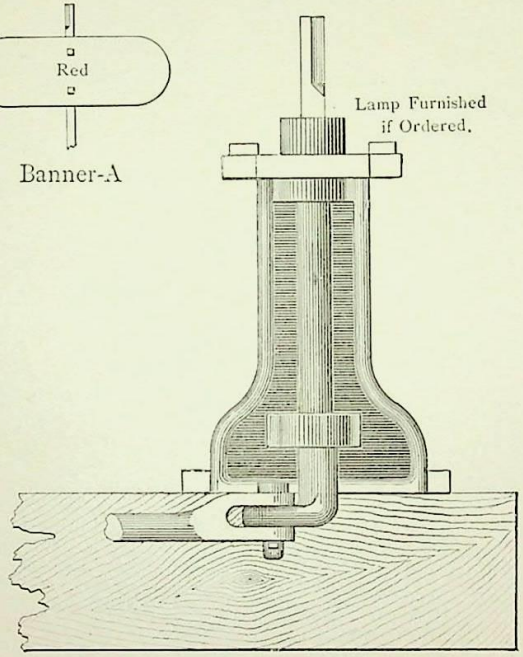
Switch Stands

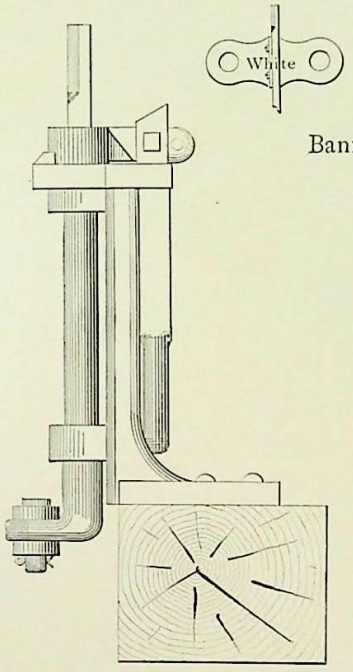


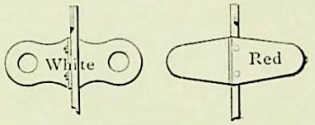
Low Target Stand
For Yard Use



Banner-A



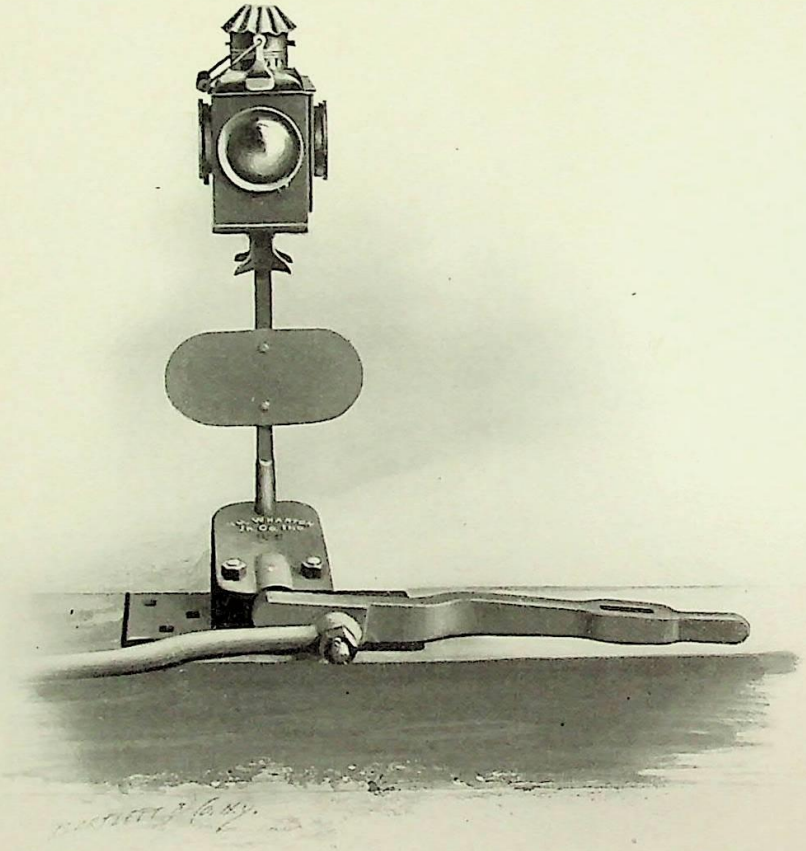




Banner-B

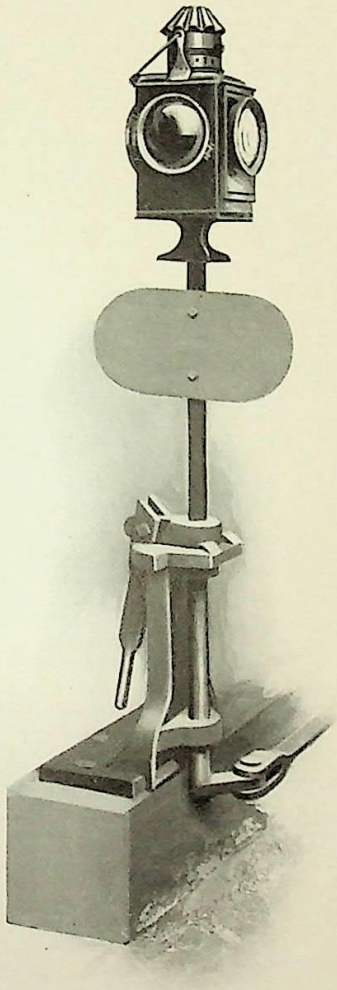
No. 8 Switch Stand

Switch Stands

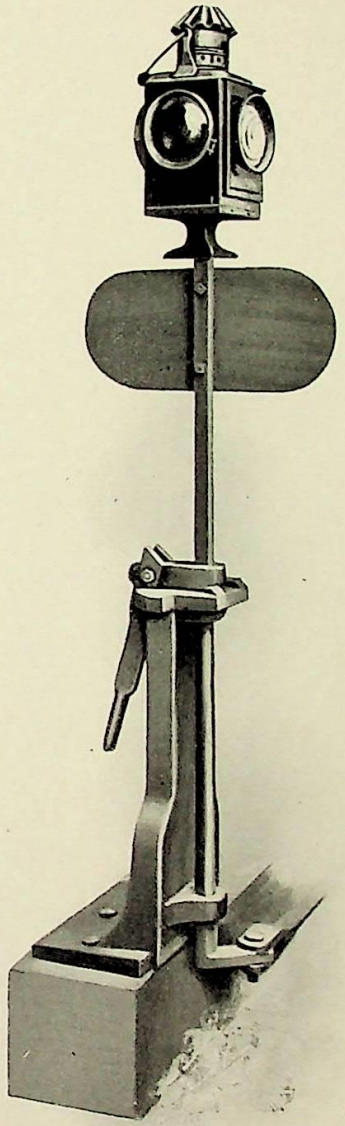


No. 10 Combination Ground Throw and Low Target, with Lamp

Same as page 121



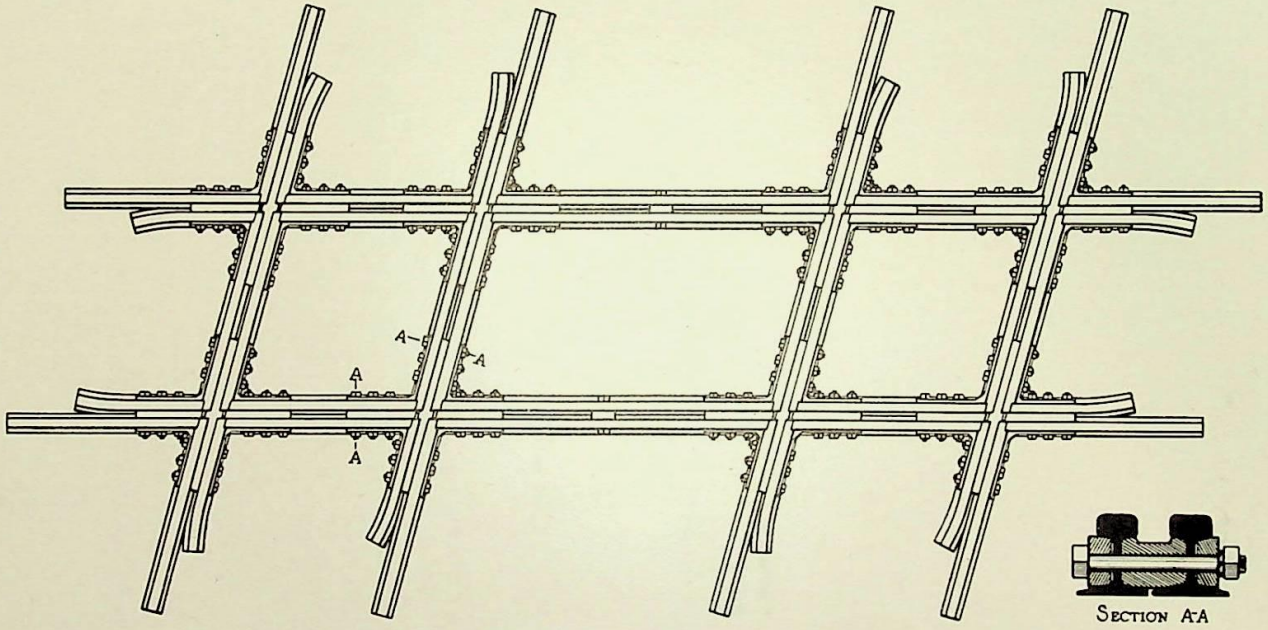
No. 8 Switch Stand



No. 9 Switch Stand

Crossings, Steam Railroad Over Steam Railroad

Two-rail Type



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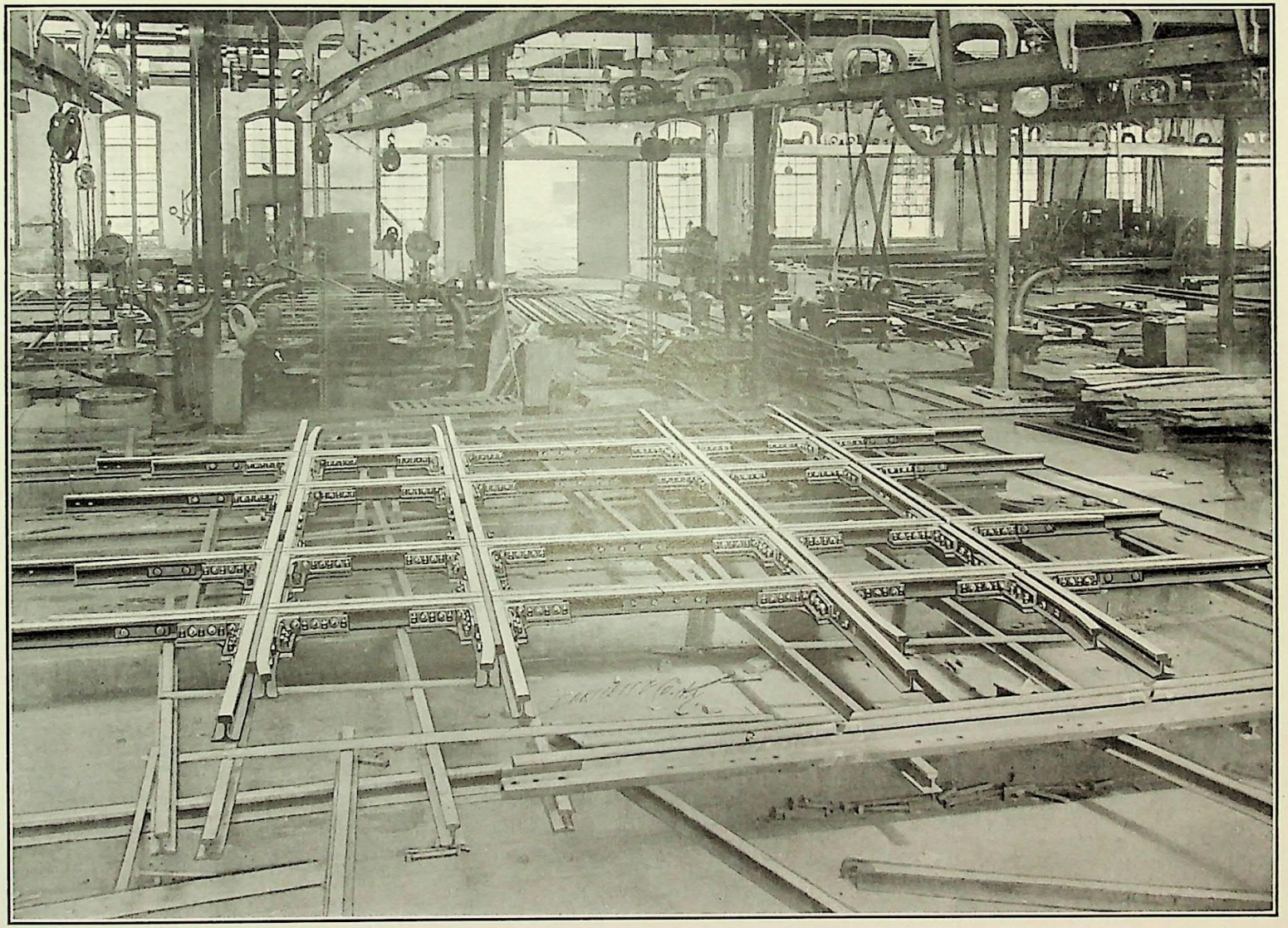
Crossings, Steam Railroad Over Steam Railroad

Two-rail Type

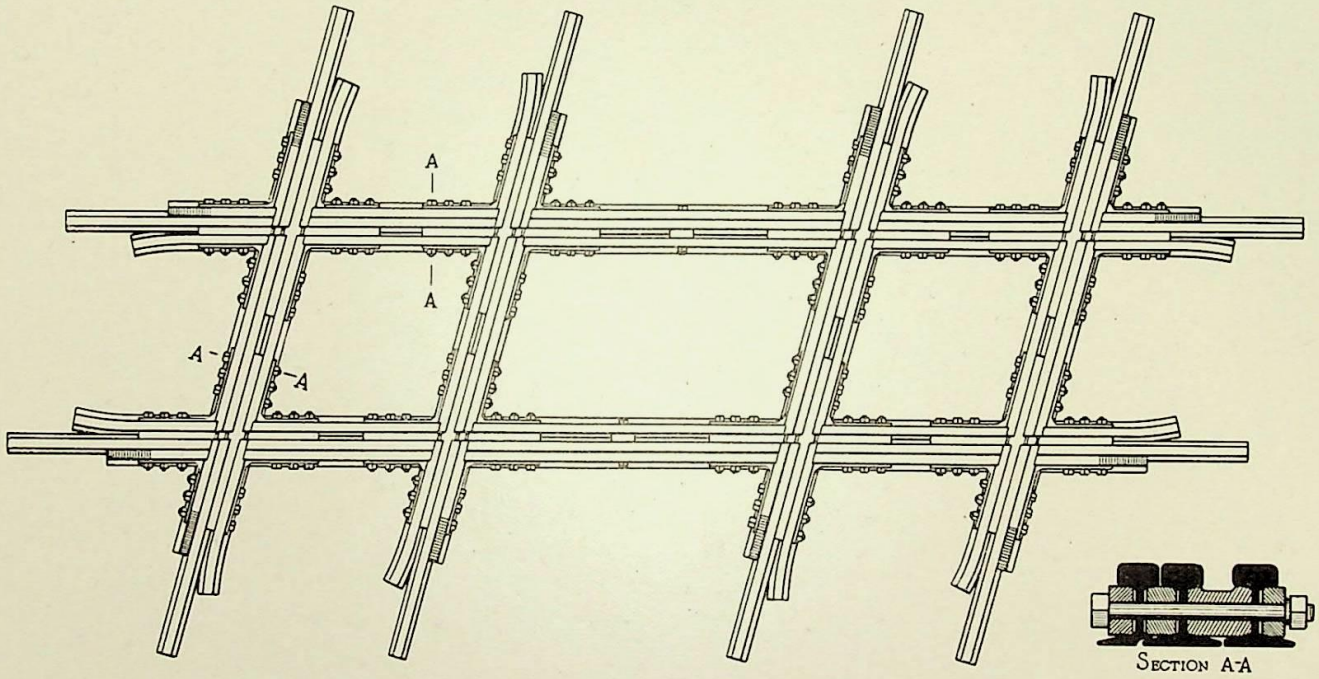


Heavy reinforced angle knees. Made with or without plates under corners. Cast iron and cast or rolled steel fillers, as may be desired.

132101

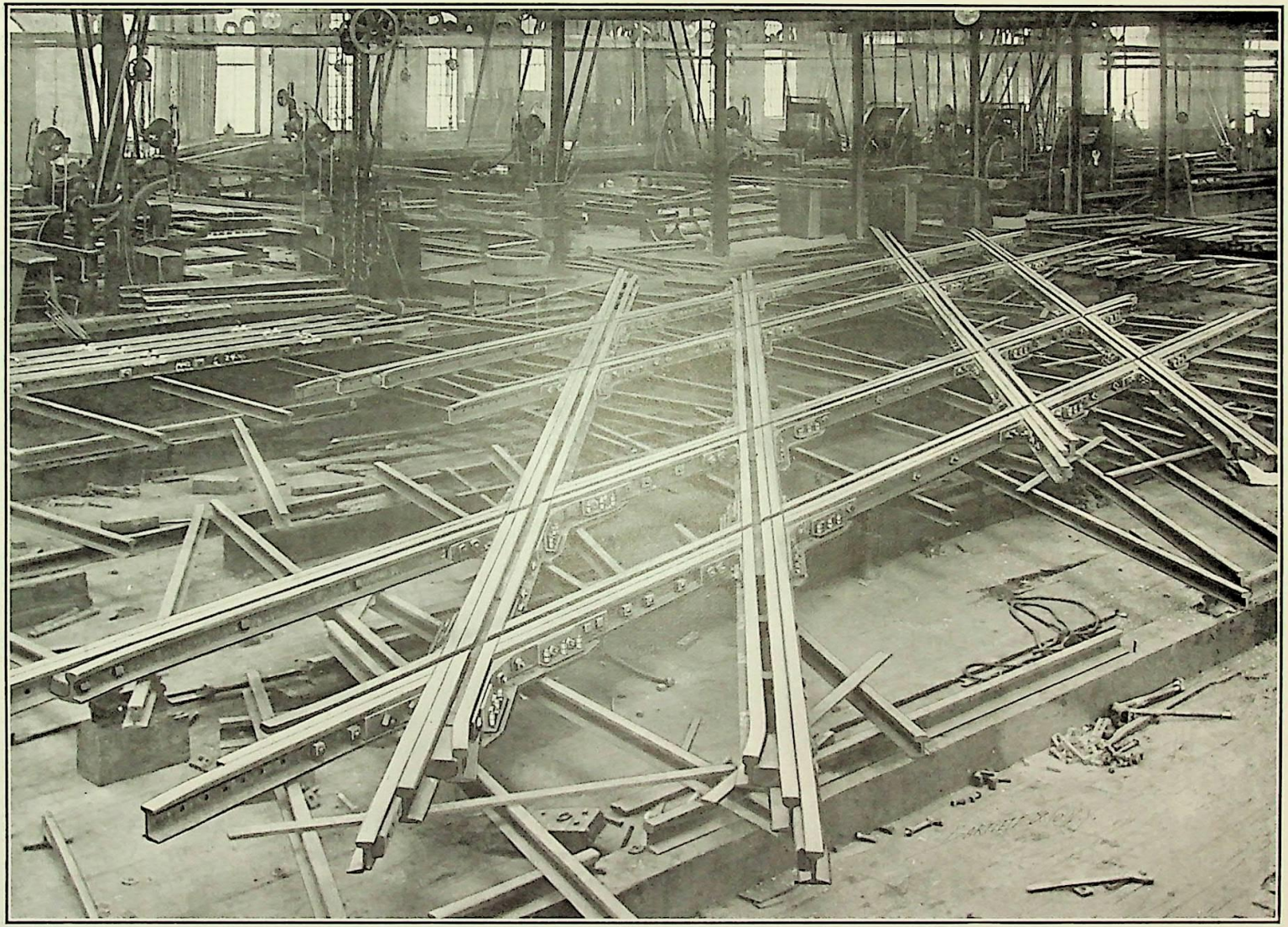
Crossings, Steam Railroad Over Steam Railroad

Three-rail Type



Crossings, Steam Railroad Over Steam Railroad

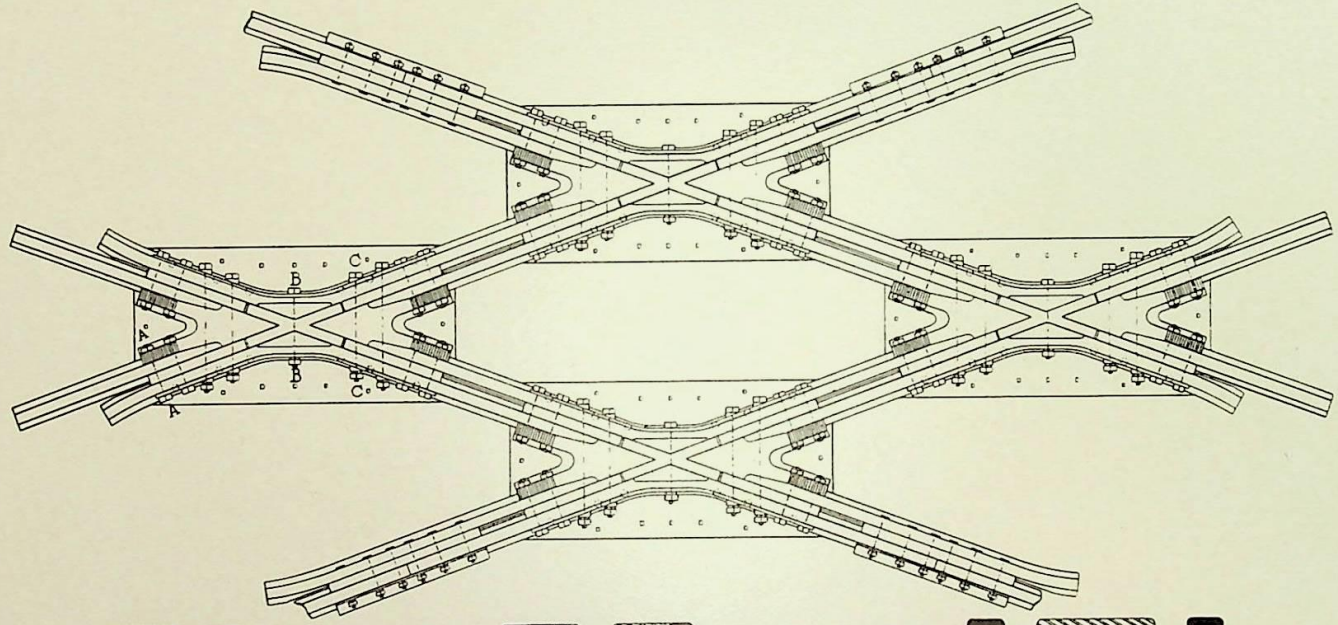
Three-rail Type



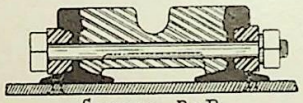
Same as page 125 except three-rail type. Third rail on the outside of the running rail protects the crossing rails from the blows of worn wheels.

Manganese Steel Crossings

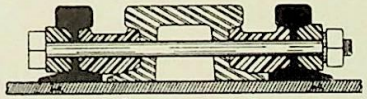
Patented June 25, 1901 and September 17, 1901



SECTION A-A



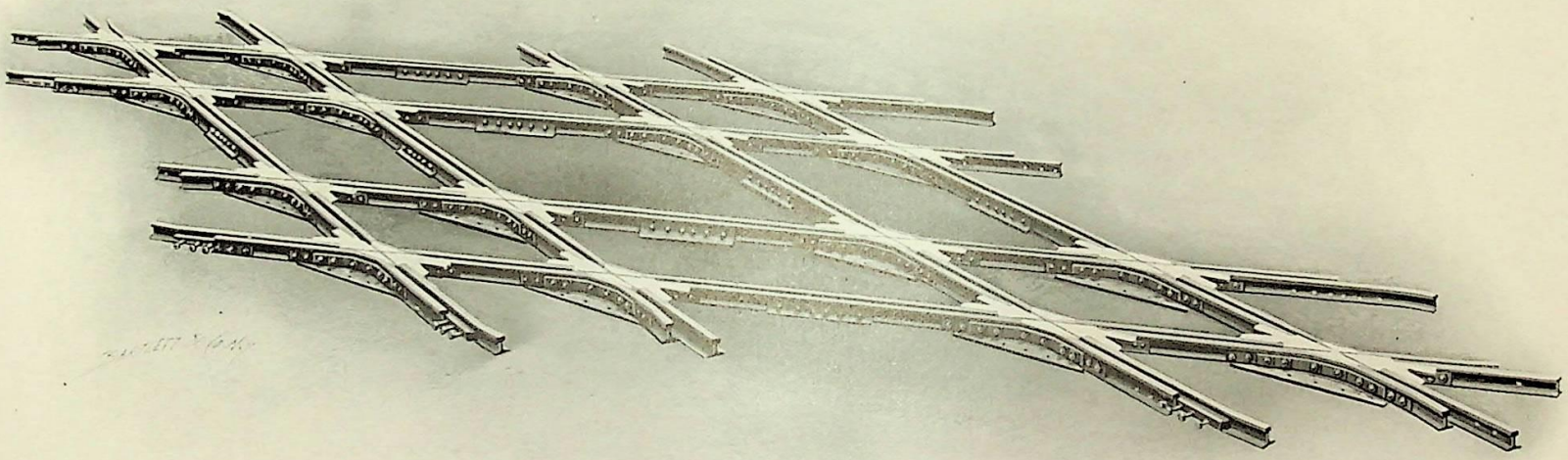
SECTION B-B



SECTION C-C

Manganese Steel Crossings

Patented June 25, 1901, and September 17, 1901



Crossings constructed on the principle of the Manganese Steel Frogs. They are expensive in first cost, but will last many times longer than crossings made throughout of rail, and are therefore very much more economical in the end.

Double Slip Crossings with Movable-point Frogs

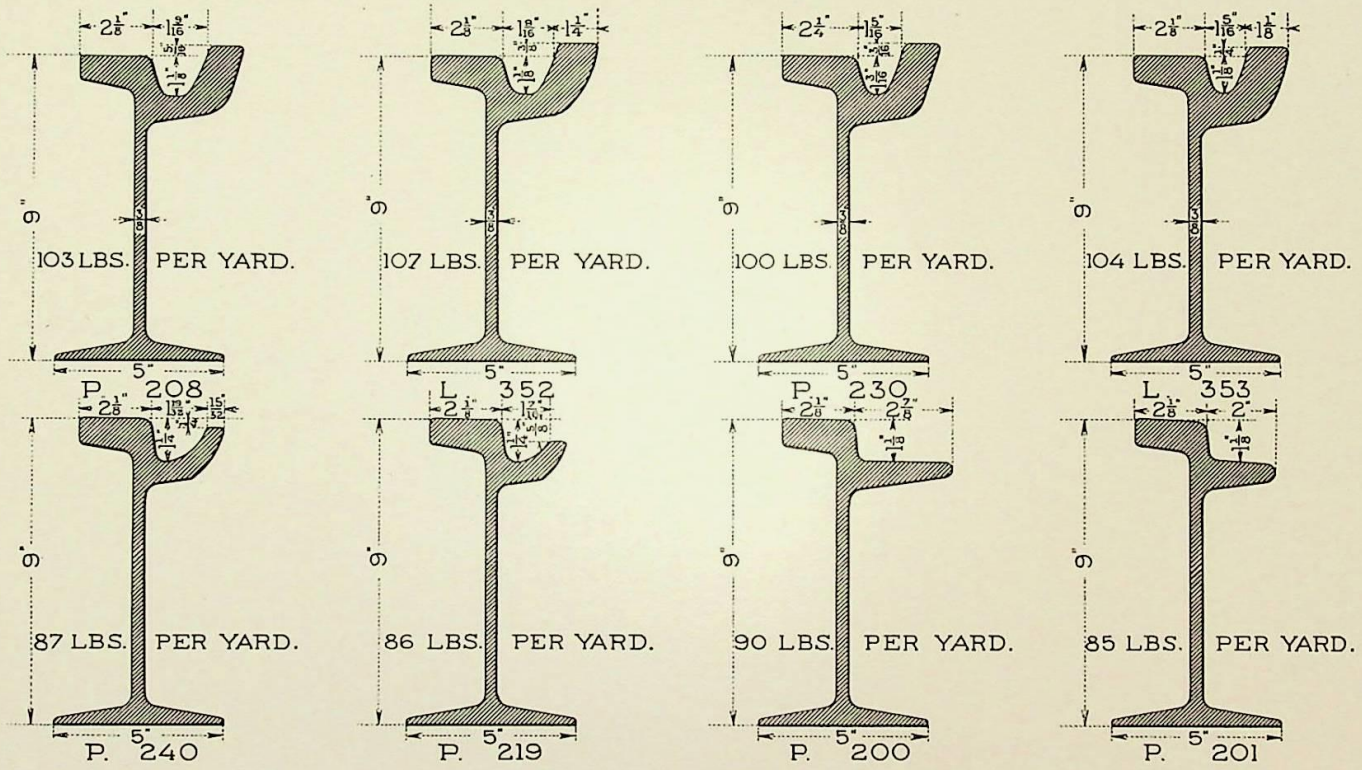
Located near Wayne Junction, Philadelphia, Pa. The photograph represents one of many built for the Philadelphia & Reading Railway Company.

Rails

THE illustrations on the following pages represent, on a reduced scale, the sections of practically all GIRDER and HIGH TEE RAILS which are now rolled in this country and in extensive use both here and abroad. We are prepared to furnish these rails with or without the usual appurtenances, and inquiries are solicited. We also deal in TEE RAILS of the usual standard sections.

Girder Rail Sections

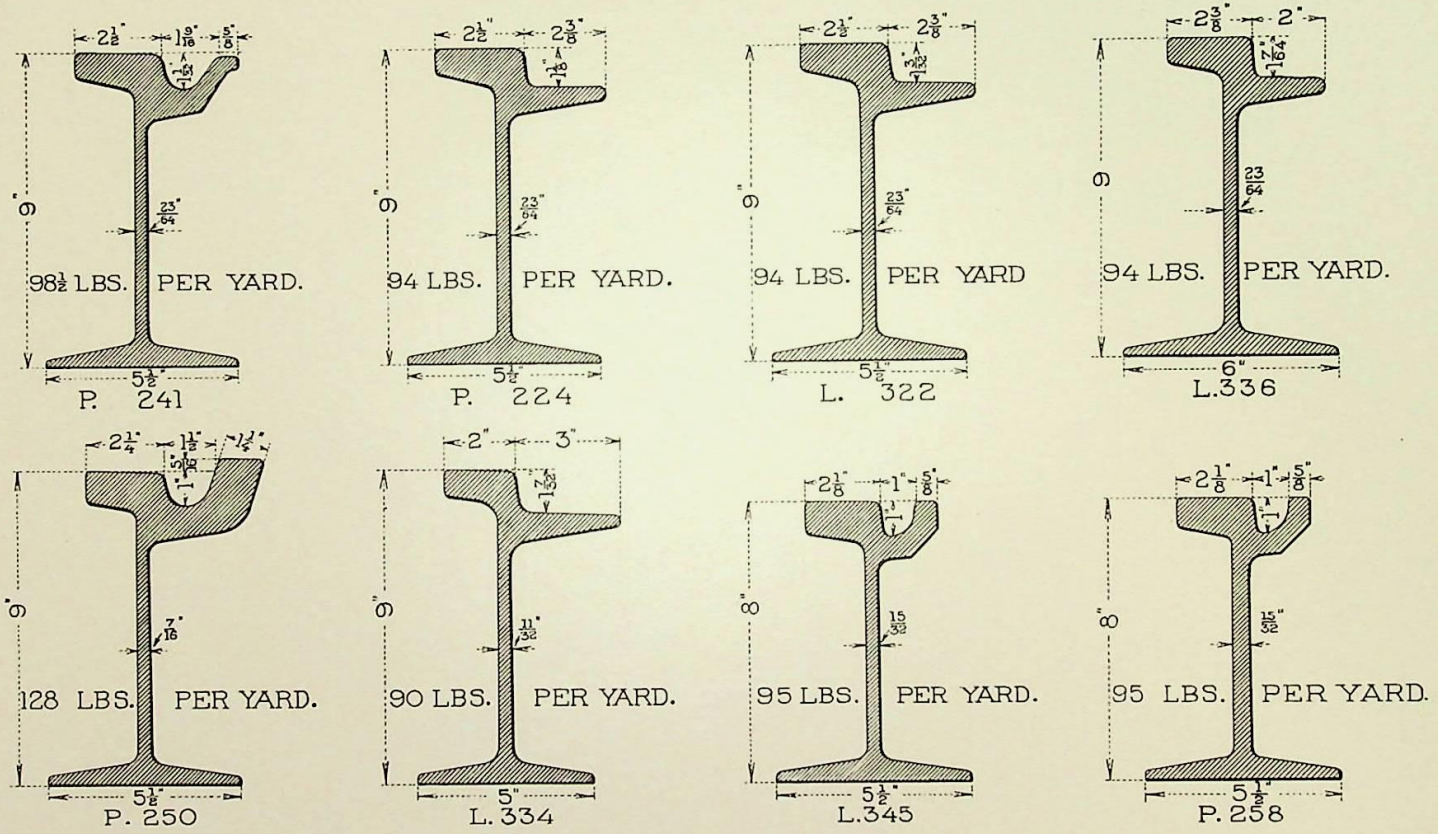
9 Inches high



Sections P.208, 230, 240, 219, 200, 201, and L.352 and 353, fish with one another.

Girder Rail Sections

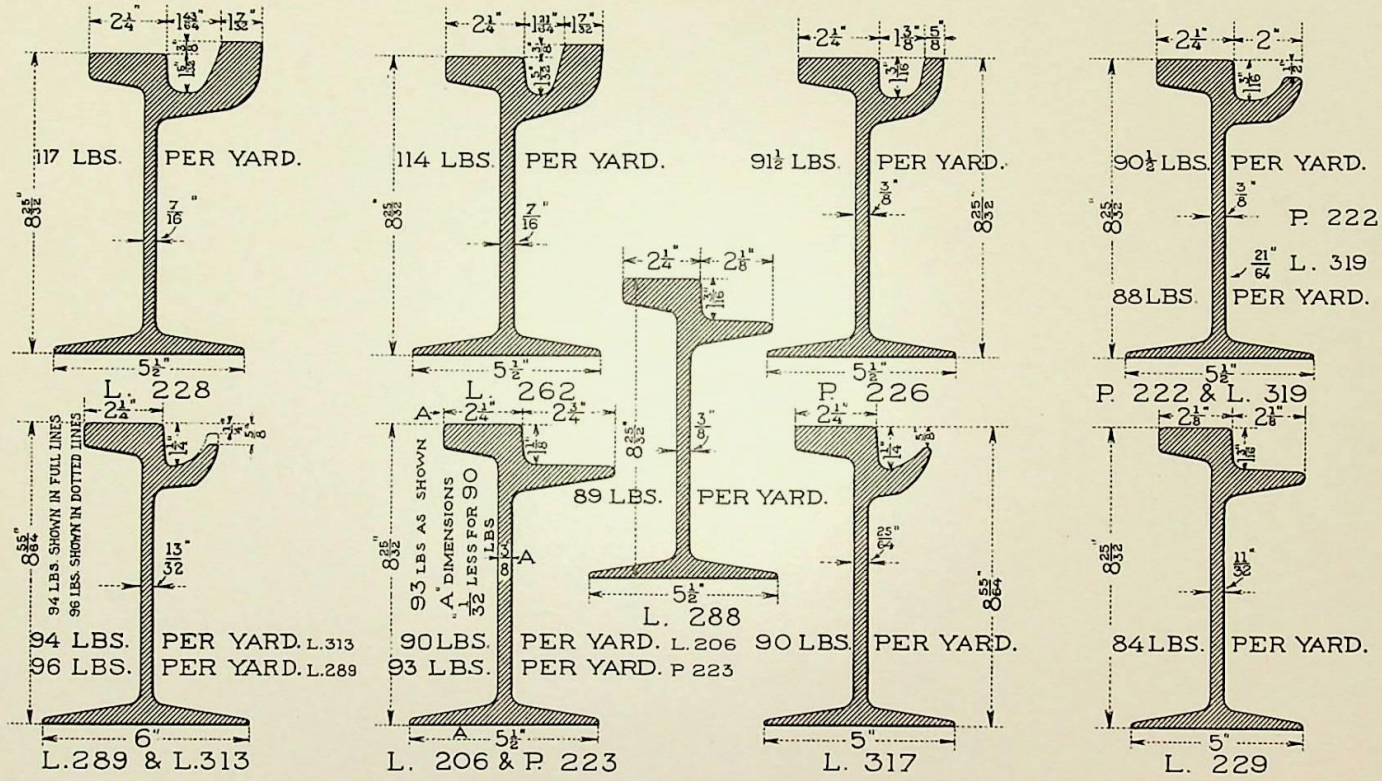
9 Inches and 8 Inches high



Sections P.241 and 224, and L.322 and 336, fish with one another. Sections P.258 and L.345, fish with each other.

Girder Rail Sections

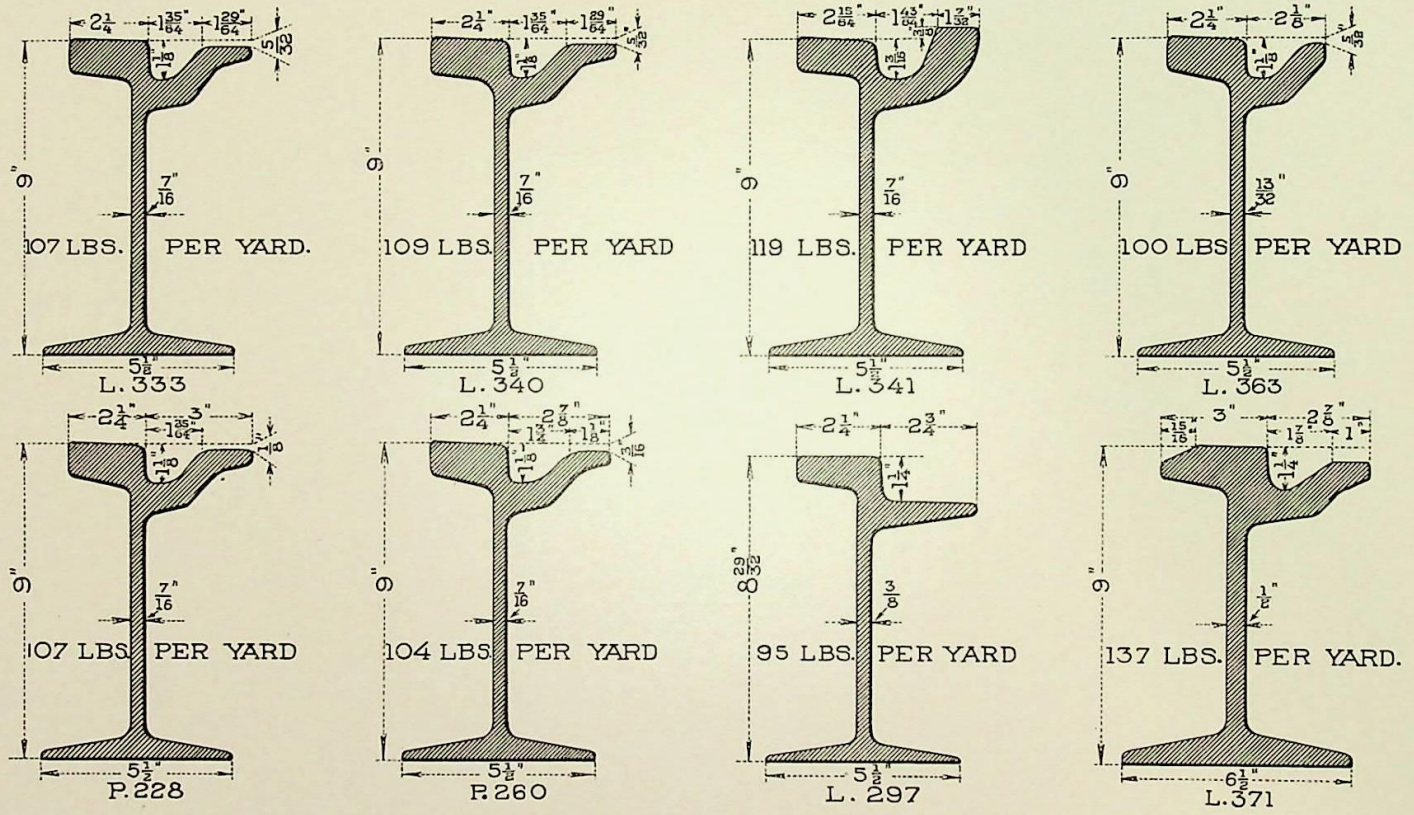
Between 9 Inches and 8 Inches high



Sections P.222, 223 and 226, and L.228, 206, 262, 288, 289, 229, 319, 313 and 317, fish with one another.

Girder Rail Sections

9 Inches and $8\frac{29}{32}$ Inches high

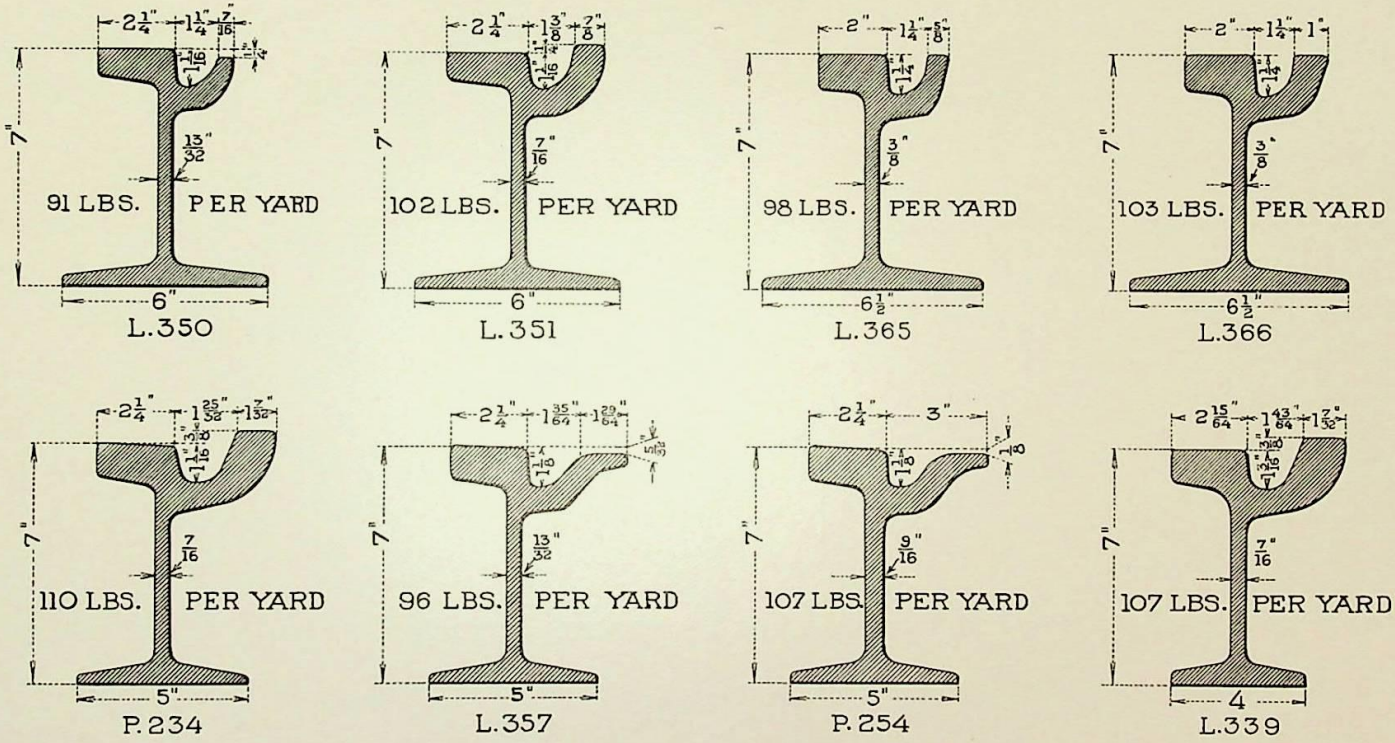


Sections P.228 and 260, and L.333, 340, 341 and 363, fish with one another.

NOTE.—L.340 plates will fit L.333, 341 and 363, and P.228 and 260. Their plates will not fit L.340, on account of fillet under head.

Girder Rail Sections

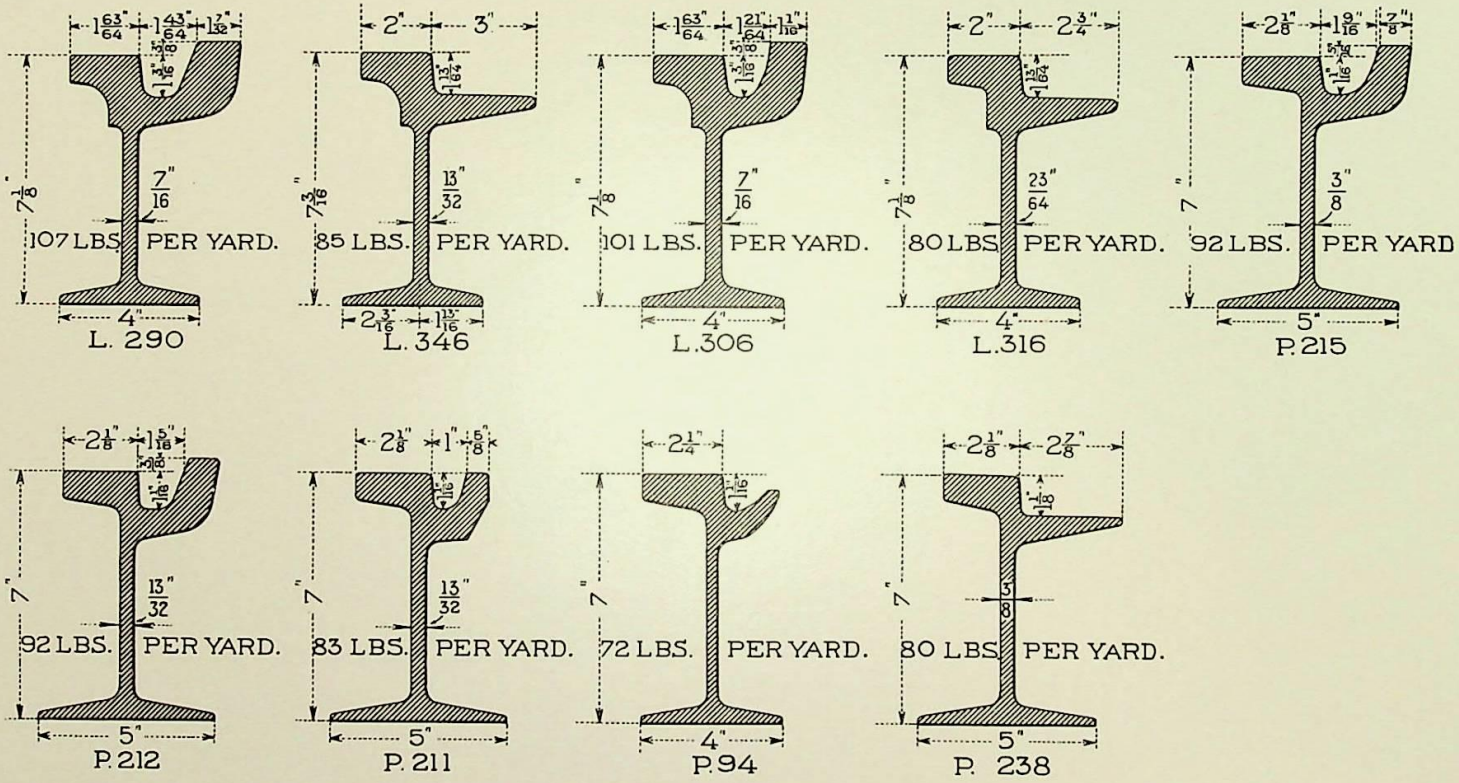
7 Inches high



Sections L.350 and 351, fish with each other. Sections L.365 and 366, fish with each other. Sections P.234 and L.357, fish with each other. Sections P.254 and L.339, fish with each other.

Girder Rail Sections

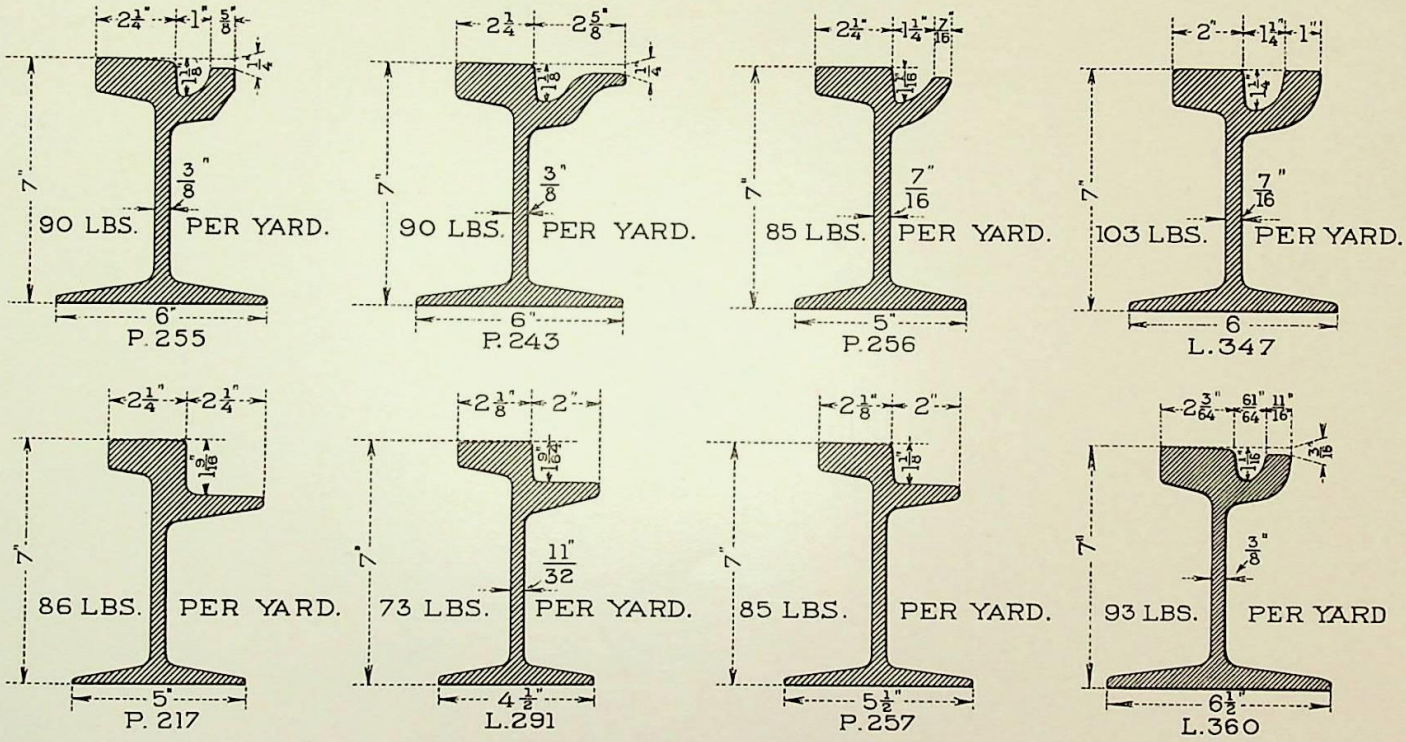
Between 8 Inches and 7 Inches high



Sections L.290, 306, 346 and 316, fish with one another. Sections P.215, 212, 211, 94 and 238, fish with one another.

Girder Rail Sections

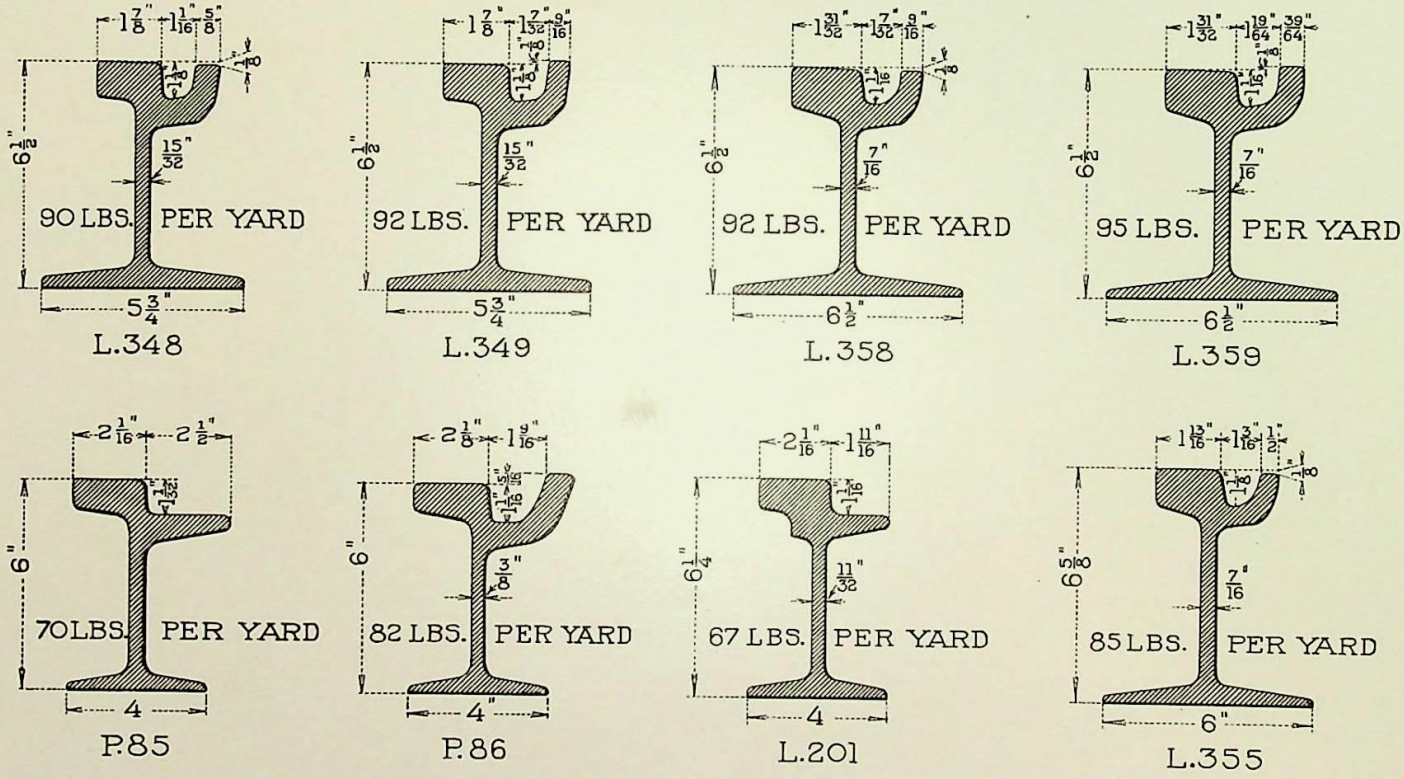
7 Inches high



Sections P.255 and 243, fish with each other.

Girder Rail Sections

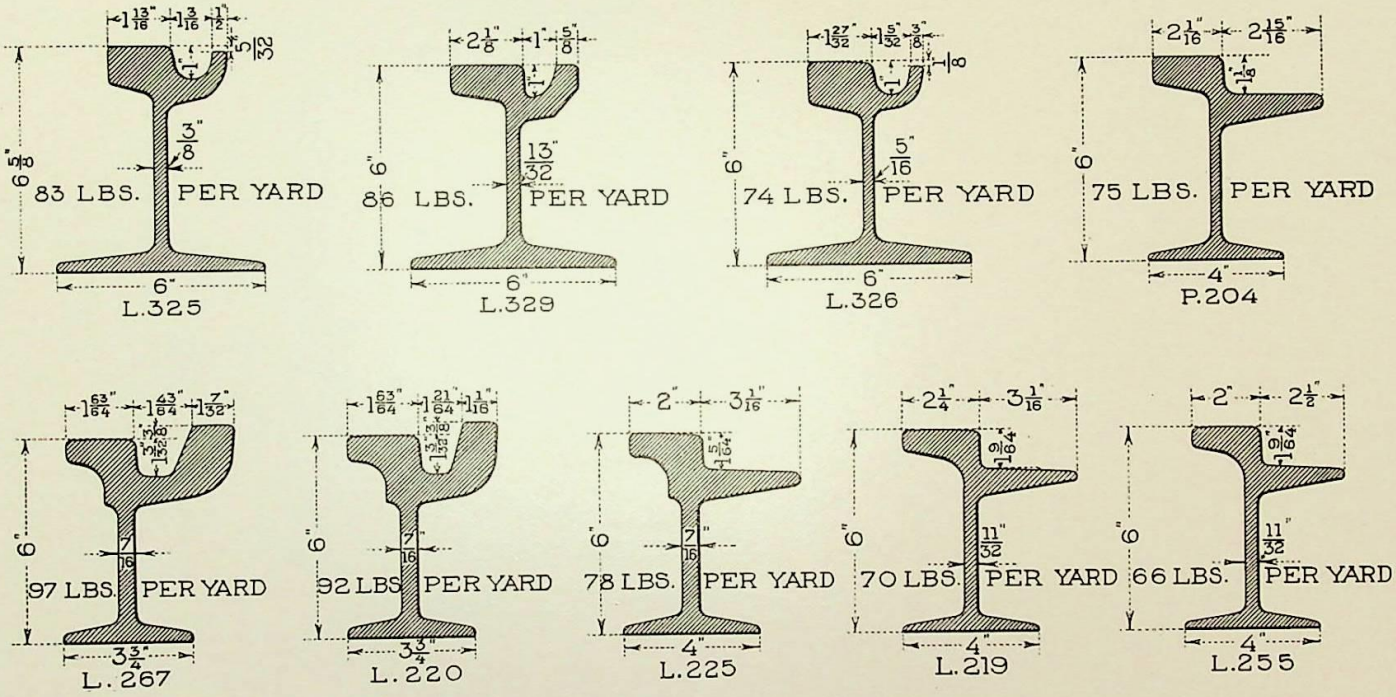
Between 7 Inches and 6 Inches high



Sections L.348 and 349, fish with each other. Sections L.358 and 359, fish with each other. Sections P.85 and 86, fish with each other.

Girder Rail Sections

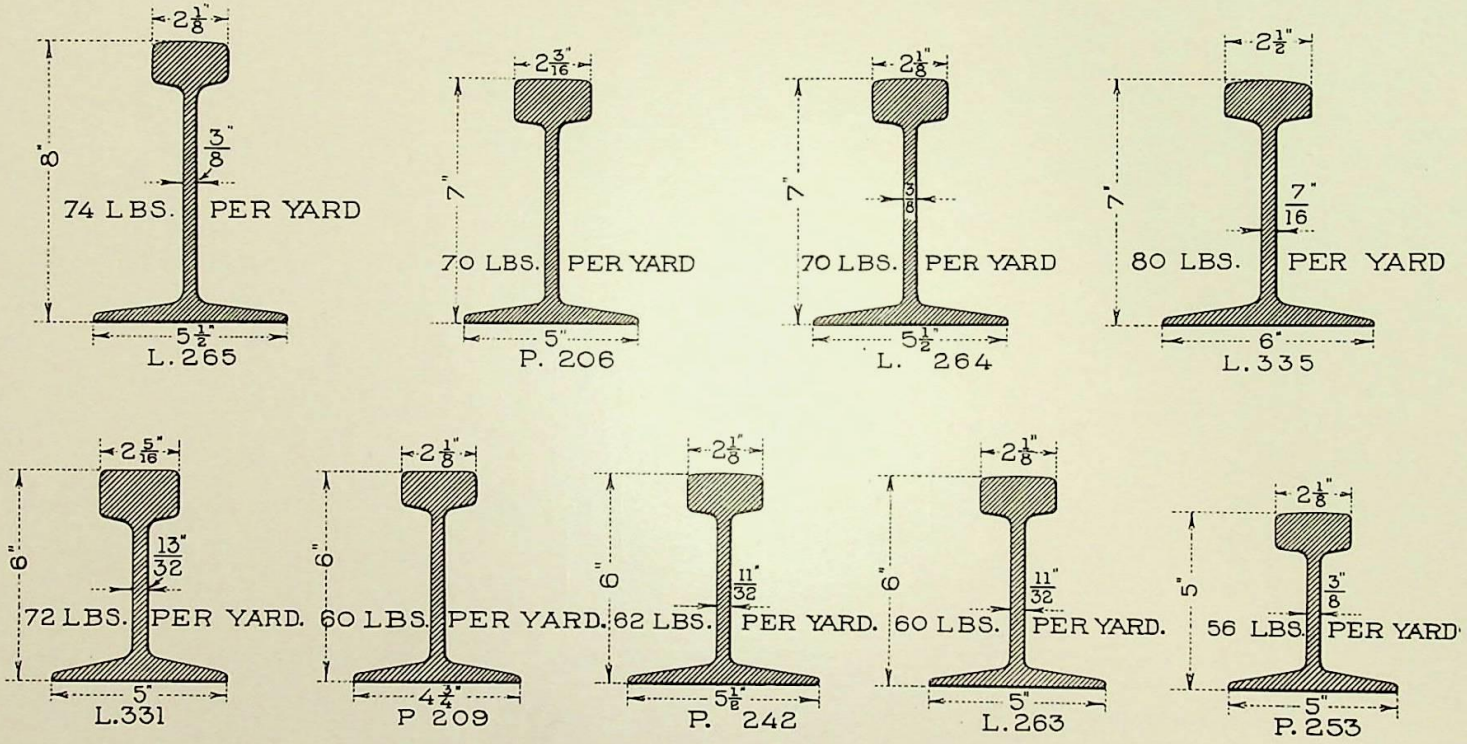
Between 7 Inches and 6 Inches high



Sections L.267, 220 and 225, fish with one another. Sections L.219 and 255, fish with each other.

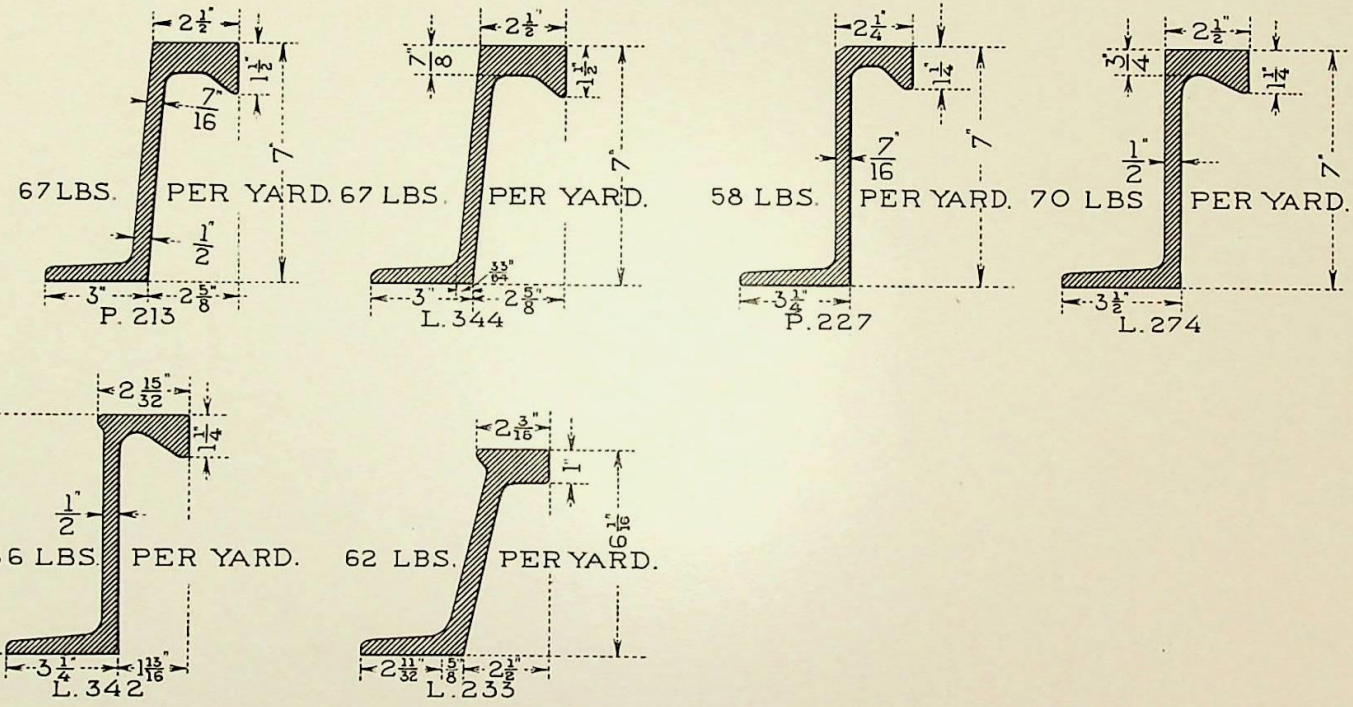
High Tee-Rail Sections

Between 8 Inches and 5 Inches high



Sections P.206 and L.264, fish with each other. Sections P.242 and 209, and L.363, fish with one another.

Slot Rail Sections



Engineering Data for Street Railways

Special Track Layouts

IN giving information for making a special track layout, give as far as possible such dimensions as are called for on the following sketches.

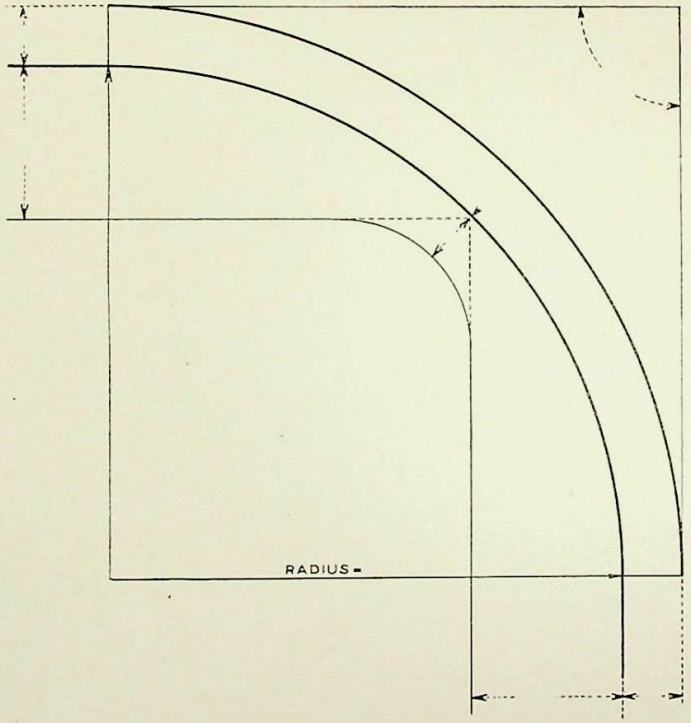
Locate all manholes and other obstructions in the street which are to be cleared by the new tracks.

Give make, section number, weight and joint drilling of the different kinds of rails with which the new work connects.

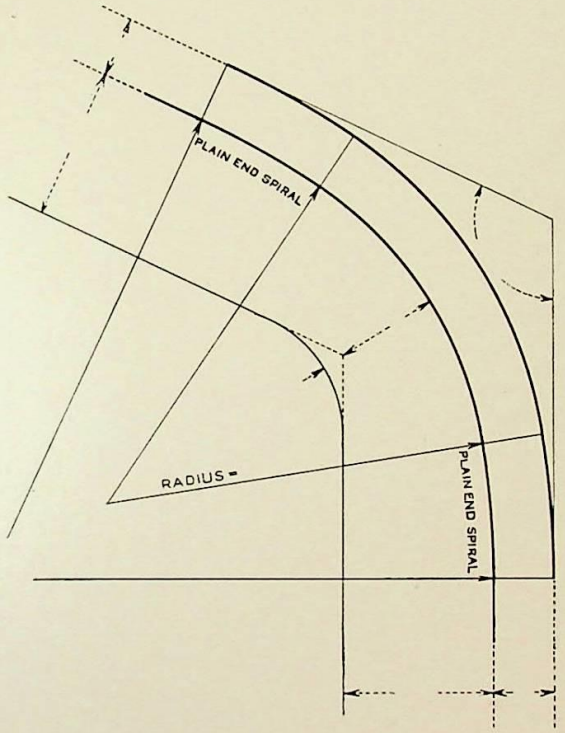
Give electric drilling of rails.

If the new work is to meet old joints, locate the old joints accurately.

Diagrams of Typical Track Layouts

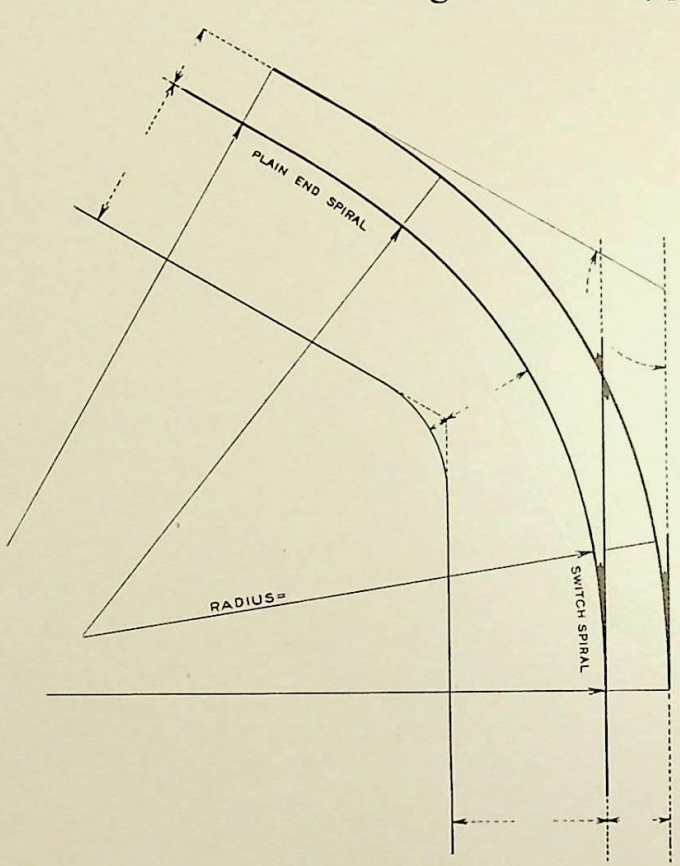


Single Track Plain Curve

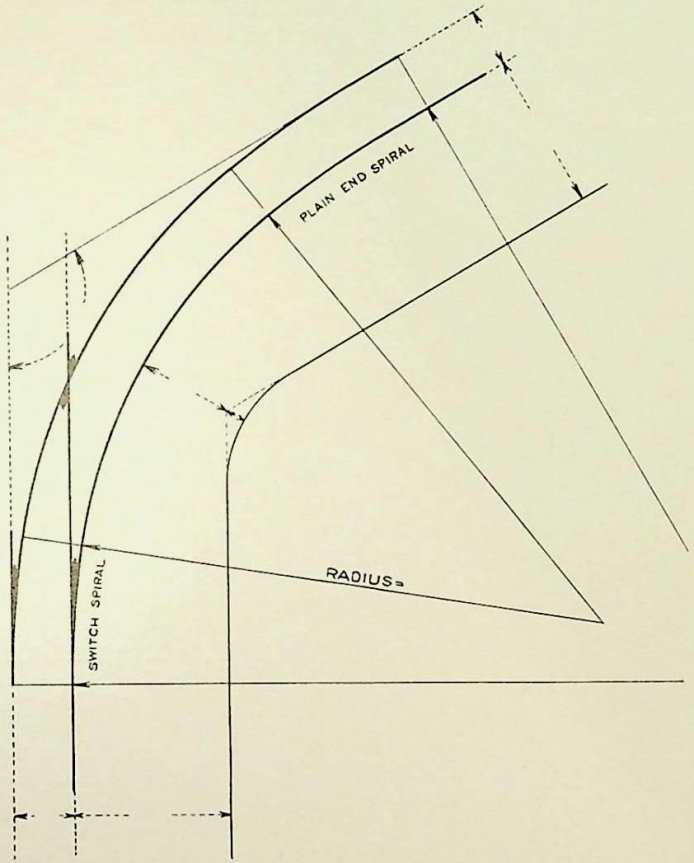


Single Track Easement Curve

Diagrams of Typical Track Layouts

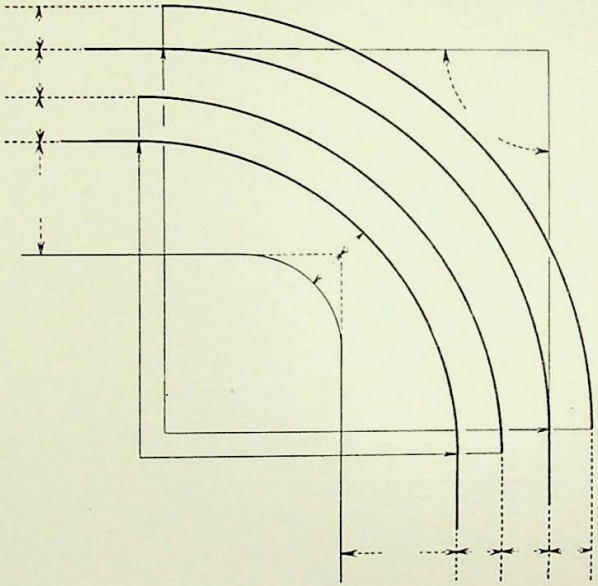


Single Track Left-hand Branch-off Curve

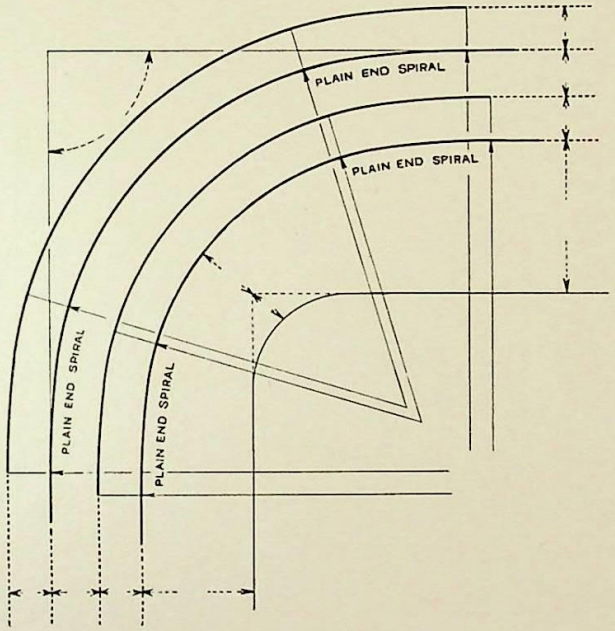


Single Track Right-hand Branch-off Curve

Diagrams of Typical Track Layouts

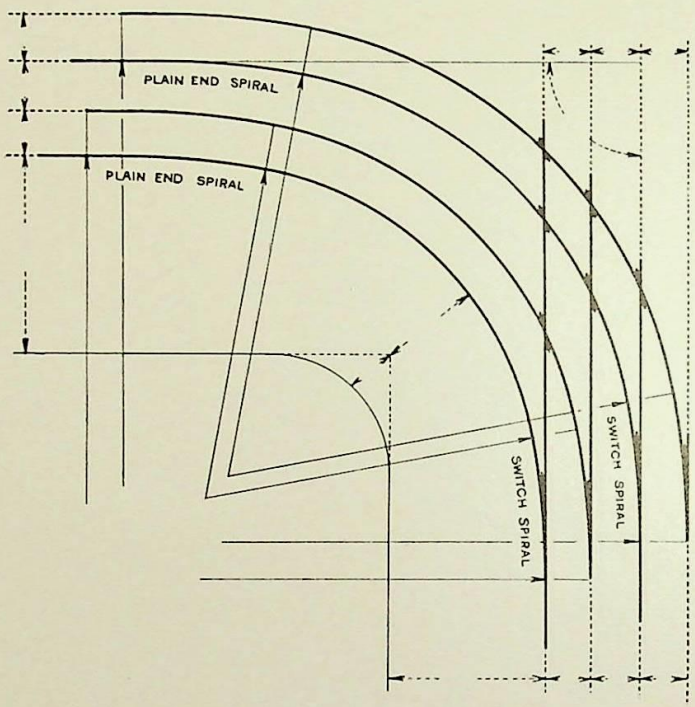


Double Track Plain Curves

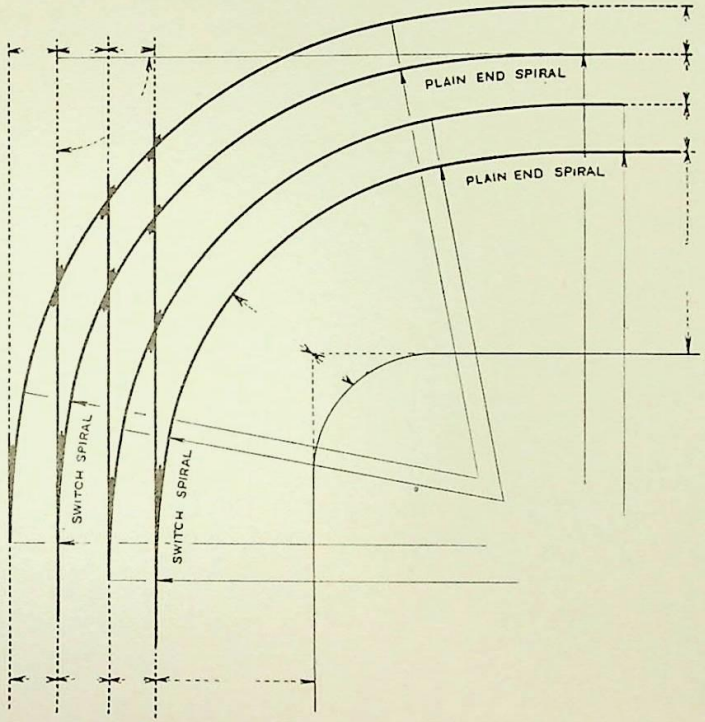


Double Track Easement Curves

Diagrams of Typical Track Layouts

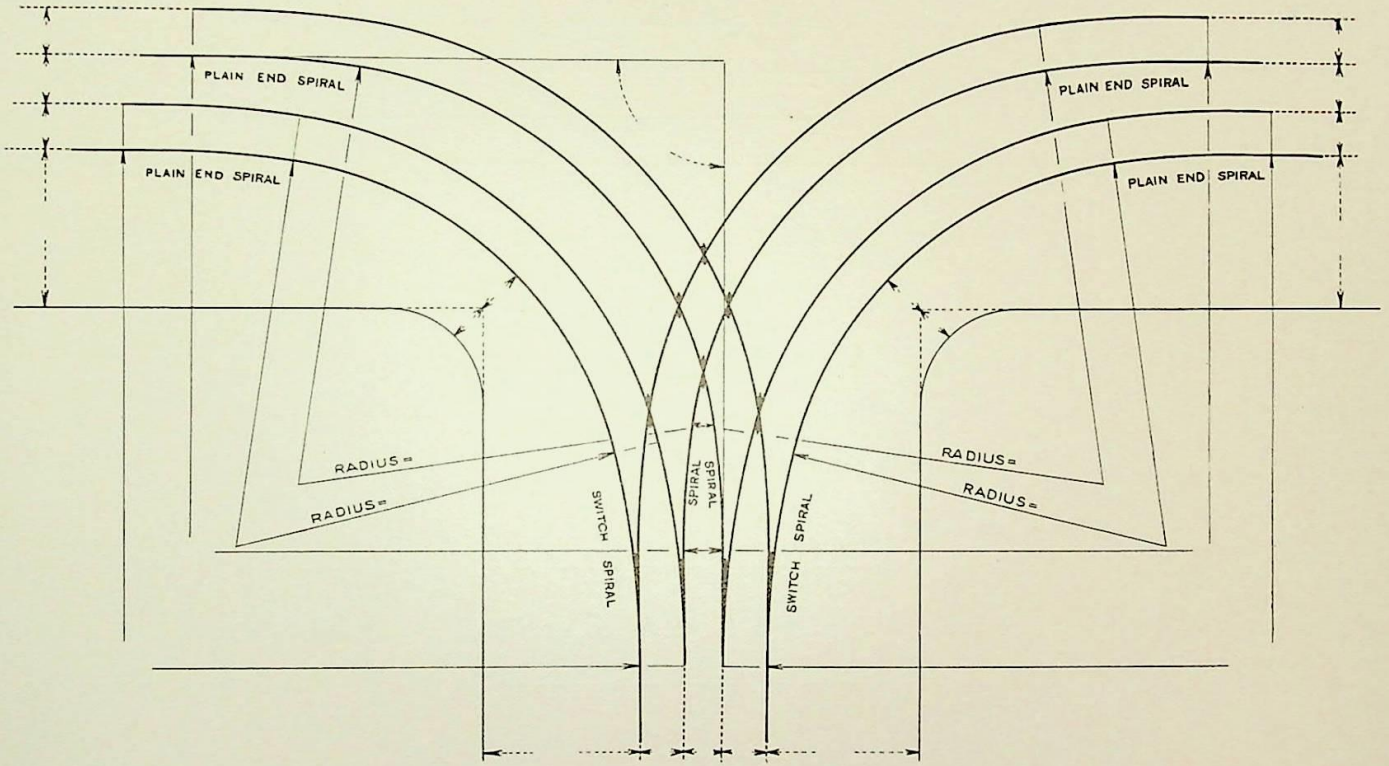


Double Track Left-hand Branch-off Curve



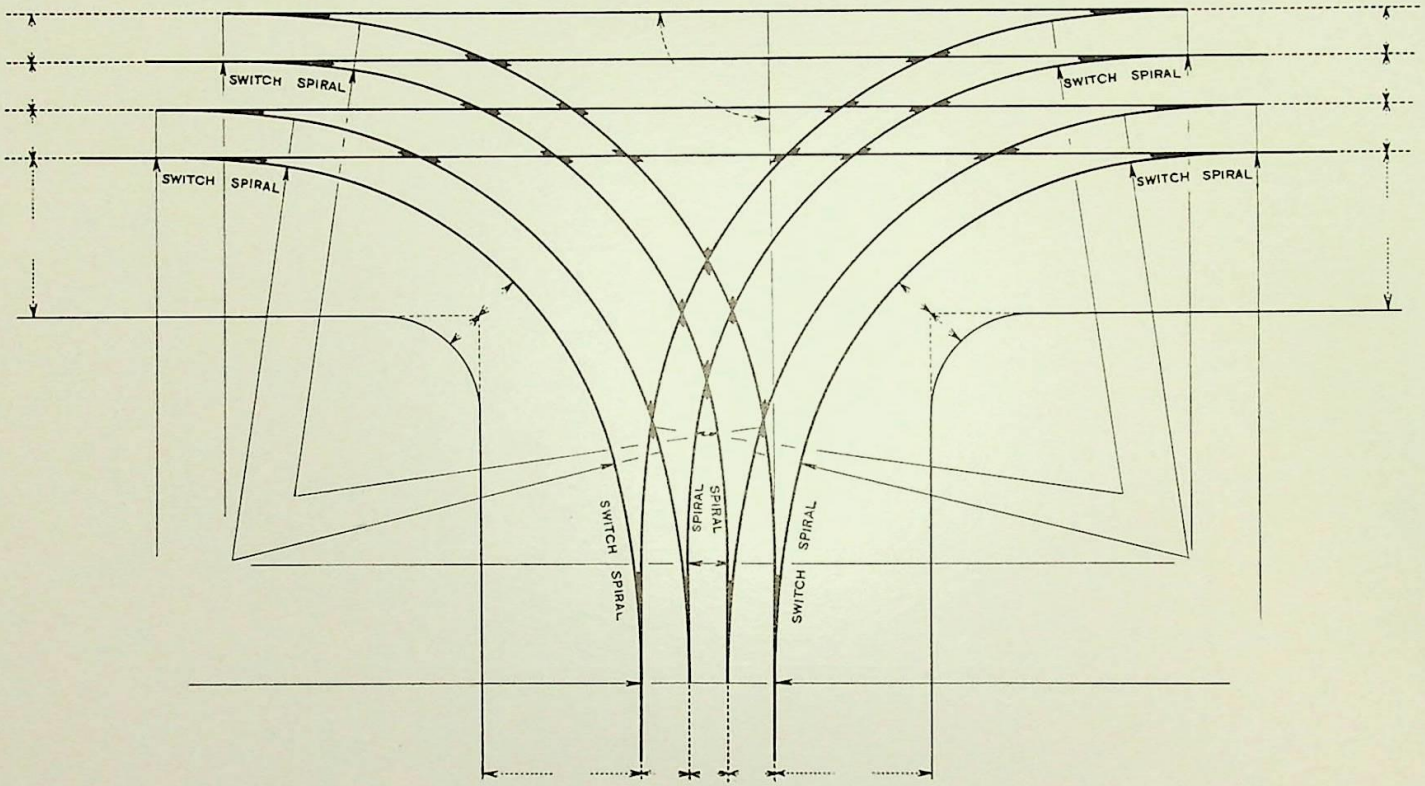
Double Track Right-hand Branch-off Curve

Diagram of Typical Track Layout



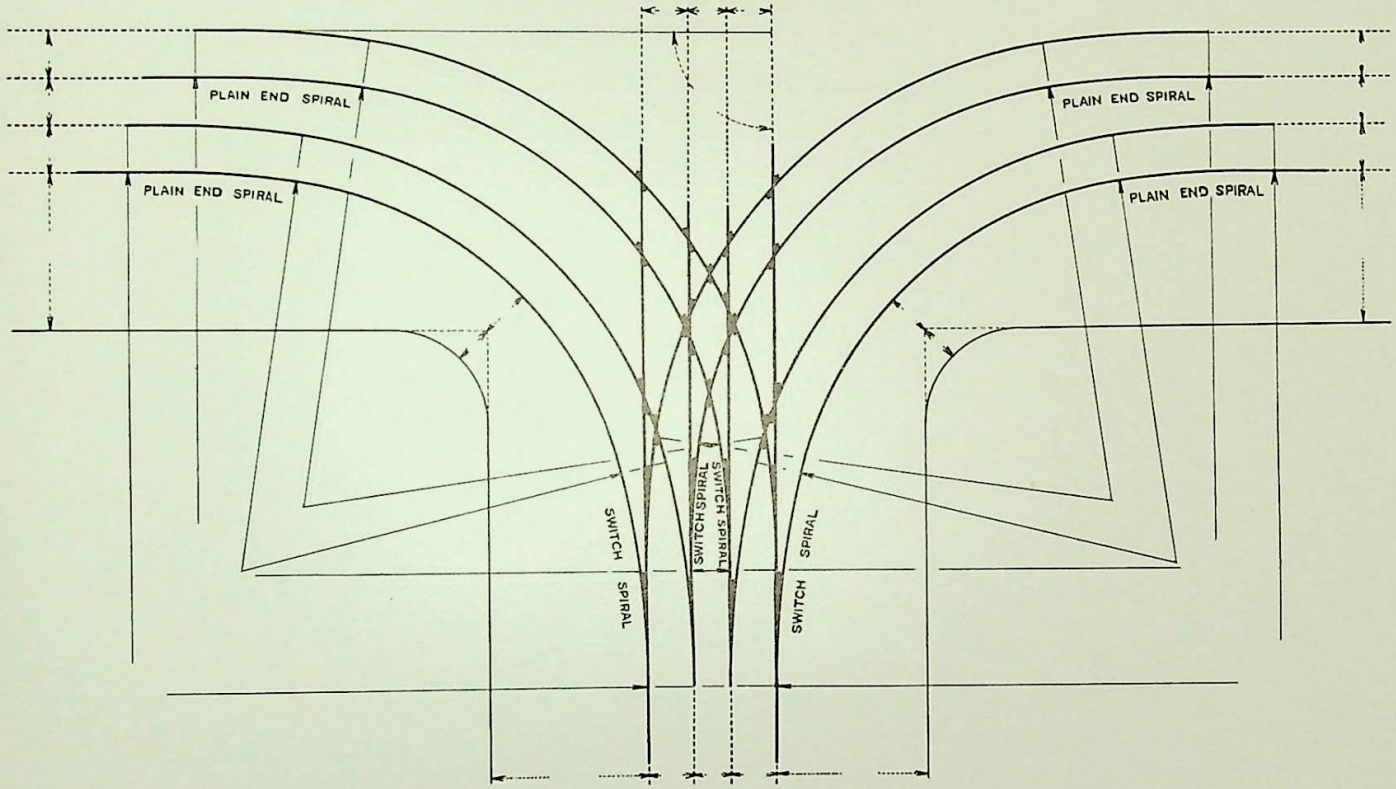
Double Track Equilateral Branch-off

Diagram of Typical Track Layout



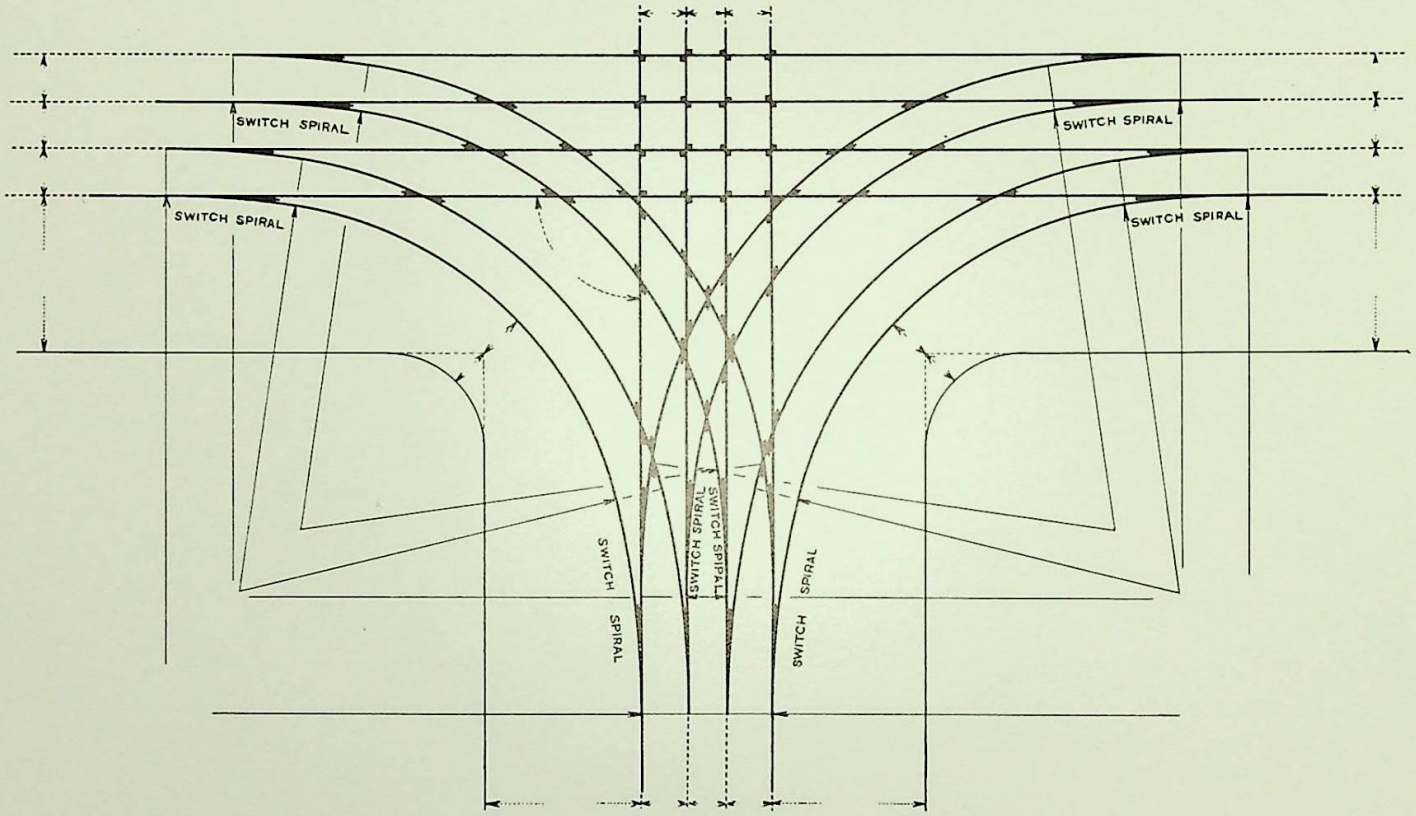
Double Track Y

Diagram of Typical Track Layout



Double Track Equilateral Branch-off with Through Tracks

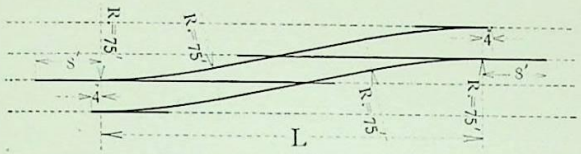
Diagram of Typical Track Layout



Double Track Y with Crossings

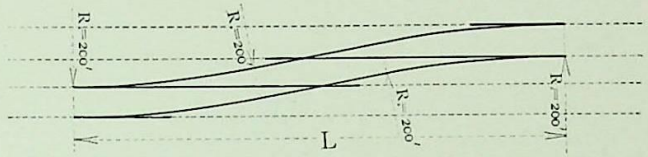
Standard Crossovers

With Tongue Switches



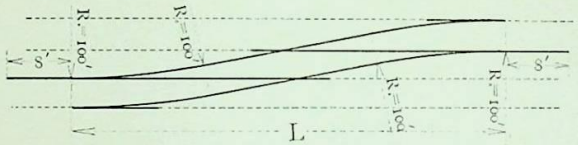
Standard "A," 75′ Rad.

Switches, 75′ Rad. Frog Angle, 15°



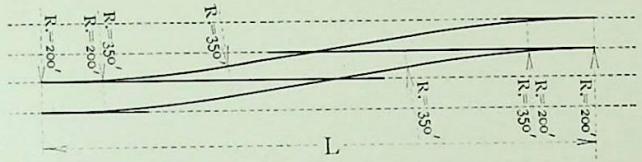
Standard "C," 200′ Rad.

Switches, 200′ Rad. Frog Angle, 9° 30′



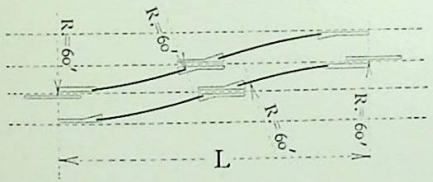
Standard "B," 100′ Rad.

Switches, 100′ Rad. Frog Angle, 13°



Standard "D," 200′ and 350′ Rad.

Switches, 200′ Rad. Angle, 7° 30′



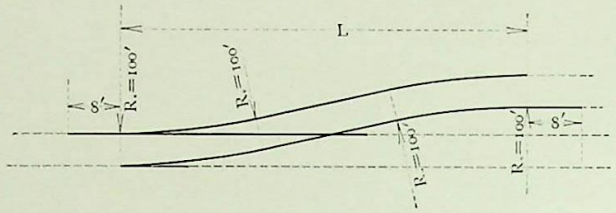
Standard "E," 60′ Rad.

Unbroken Main Line Switches, 60′ Rad.
Frog Angle, 18°

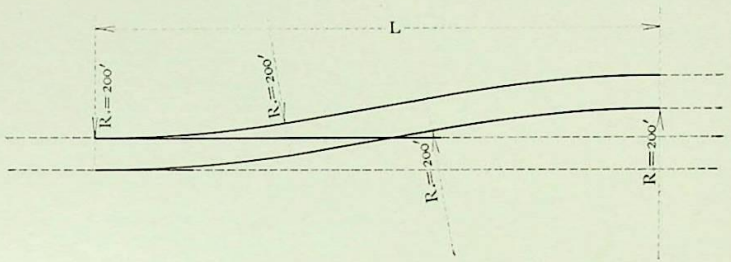
4′ 0″ between tracks . .	4′ 8½″ Gauge					5′ 2¼″ Gauge					Var. for 1″ in Gauge					Var. for 1″ between Tracks				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Length over all between tangent points "L"	52′ 10 7/16″	61′ 0½″	85′ 8″	96′ 4 7/16″	46′ 6⅝″	54′ 8⅝″	63′ 2 1/16″	88′ 6⅞″	100′ 0½″	48′ 1¼″	.321975	.370451	.504905	.638441	.269672	.311004	.360956	.497980	.632979	.256474
Lineal feet of rail in cross-over outside of switches and frogs .	90′ 1 7/16″	111′ 10 1/16″	145′ 6 1/16″	174′ 8⅞″	35′ 6 9/16″	97′ 7 13/16″	120′ 6¼″	157′ 3″	189′ 5⅞″	38′ 9 5/16″	1.309592	1.500630	2.033405	2.564658	.565307	.643950	.749902	1.009810	1.276882	0.539344
Length of rail bet. switch and frog .	12′ 7⅞″	16′ 5 3/16″	25′ 6½″	31′ 0⅜″		14′ 6 1/16″	18′ 6¾″	28′ 5 5/16″	34′ 8⅜″		.321975	.370451	.504905	.638441		.000000	.000000	.000000	.000000	

Standard Lateral Turnouts

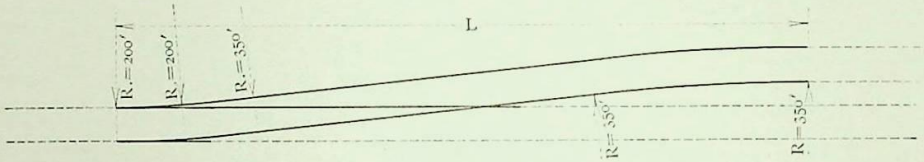
With Tongue Switches



Standard "H," 100′ Rad.
Switches, 100′ Rad. Frog Angle, 13°



Standard "I," 200′ Rad.
Switches, 200′ Rad. Frog Angle, 9° 30′

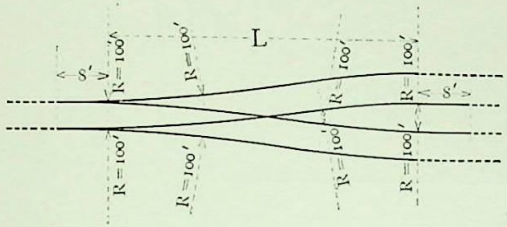


Standard "K," 200′ and 350′ Rad.
Switches, 200′ Rad. Frog Angle, 7° 30′

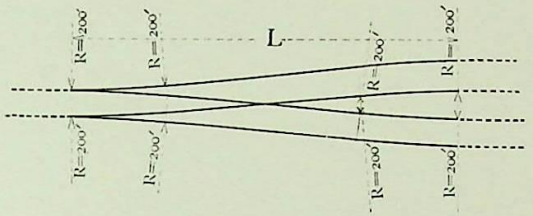
4′ 0″ between tracks . .	Gauge 4′ 8½″			Gauge 4′ 10″			Gauge 5′ 2¼″			Var. for 1″ in Gauge			Var. for 1″ between Tracks		
	H	I	K	H	I	K	H	I	K	H	I	K	H	I	K
Length over all between tangent points "L" .	61′ 0½″	85′ 8″	104′ 4¼″	61′ 7 3/16″	86′ 5⅛″	105′ 3¾″	63′ 2 1/16″	88′ 6⅞″	108′ 0¼″	0.370451	0.504905	0.638442	0.360956	0.497980	0.632980
Lineal feet of rail in turnout outside of switch and frog	125′ 9⅜″	159′ 0 3/16″	200′ 1¾″	127′ 5 11/16″	161′ 3 11/16″	203′ 0⅜″	132′ 3⅜″	167′ 9⅝″	211′ 2⅝″	1.130179	1.528500	1.926218	0.740902	1.009810	1.276883
Length of rail between switch and frog . . .	16′ 5 3/16″	25′ 6½″	31′ 0⅜″	16′ 11⅞″	26′ 3 9/16″	31′ 11 13/16″	18′ 6¼″	28′ 5 5/16″	34′ 8⅜″	0.370451	0.504905	0.638442	0.000000	0.000000	0.000000

Standard Equilateral Turnouts

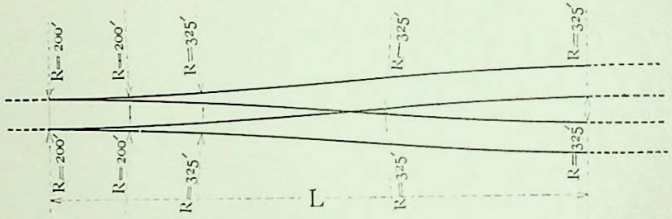
With Tongue Switches



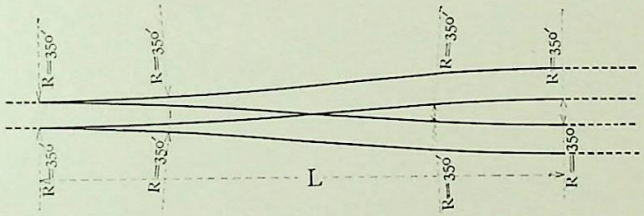
Standard "O," 100′ Rad.
Switches, 100′ Rad. Frog Angle, 15°



Standard "P," 200′ Rad.
Switches, 200′ Rad. Frog Angle, 13°



Standard "Q," 200′ and 325′ Rad.
Switches, 200′ Rad. Frog Angle, 11° 0′

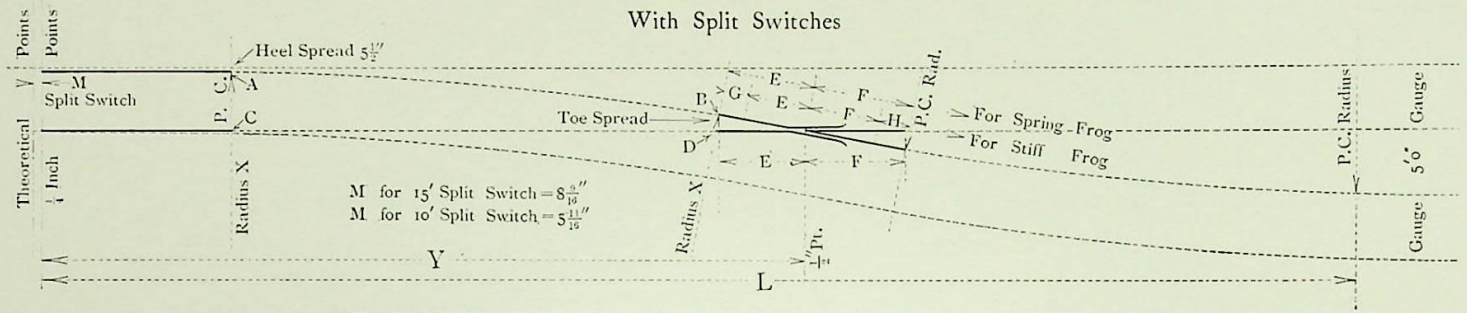


Standard "R," 350′ Rad.
Switches, 350′ Rad. Frog Angle, 9° 30′

4′ 0″ between tracks	Gauge 4′ 8½″				Gauge 4′ 10″				Gauge 5′ 2¼″				Var. for 1″ in Gauge				Var. for 1″ between Tracks			
	O	P	Q	R	O	P	Q	R	O	P	Q	R	O	P	Q	R	O	P	Q	R
Length over all between tangent points "L"	46′ 5⅞″	61′ 2⅜″	71′ 6⅛″	81′ 7/16″	46′ 11 1/16″	61′ 9″	72′ 2″	82′ 4⅝″	48′ 4⅛″	63′ 3 1/16″	74′ 0 5/16″	84′ 6⅜″	0.321952	0.370435	0.436728	0 504899	0.316490	0 365704	0.432725	0.501443
Lineal feet of rail in turnout outside of switches and frogs	159′ 5⅝″	184′ 10⅜″	225′ 0 1/16″	253′ 1¼″	161′ 5″	187′ 1¼″	227′ 7⅝″	256′ 1¾″	166′ 11 3/16″	193′ 5 1/16″	235′ 1⅛″	264′ 9 1/16″	1.298663	1.491282	1.755339	2.026493	1.276883	1.472279	1.738905	2.012682

Standard Lateral Turnouts

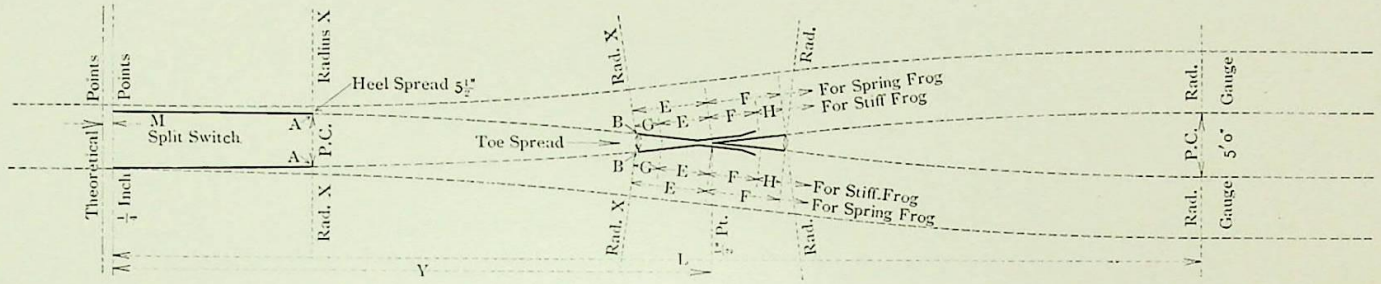
With Split Switches



5′ 0″ between Tracks	15′ Split Switch								10′ Split Switch							
Number of frog . . .	Number 8 frog				Number 6 frog				Number 8 frog				Number 6 frog			
Style of frog	Spring		Stiff		Spring		Stiff		Spring		Stiff		Spring		Stiff	
Gauge	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″
Length over all L . .	137′ 5 1/16″	143′ 7 9/16″	137′ 5 1/16″	143′ 7 9/16″	105′ 1″	109′ 11 9/16″	105′ 1″	109′ 11 9/16″	128′ 7⅜″	134′ 3½″	128′ 7⅜″	134′ 3½″	97′ 10¾″	102′ 5¼″	97′ 10¾″	102′ 5¼″
Frog setting Y	66′ 2 15/16″	72′ 5 7/16″	66′ 2 15/16″	72′ 5 7/16″	53′ 9½″	58′ 8 1/16″	53′ 9½″	58′ 8 1/16″	57′ 5¼″	63′ 1⅜″	57′ 5¼″	63′ 1⅜″	46′ 7¼″	51′ 1¾″	46′ 7¼″	51′ 1¾″
Radius at switch end.	462.7301	527.5995	462.7301	527.5995	232.4002	267.9930	232.4002	267.9930	498.6223	568.5205	498.6223	568.5205	241.9672	279.0239	241.9672	279.0239
Angle at switch end .	5° 29′ 44″				7° 53′ 21″				4° 39′ 35″				7° 03′ 12″			
Radius at plain end .	506.9278				261.3515				506.9278				261.3515			
Angle at plain end . .	7° 10′ 00″				9° 33′ 37″				7° 10′ 00″				9° 33′ 37″			
Length of frog arm E	7′ 0″		4′ 0″		7′ 0″		4′ 0″		7′ 0″		4′ 0″		7′ 0″		4′ 0″	
Length of frog arm F	8′ 0″		6′ 0″		8′ 0″		6′ 0″		8′ 0″		6′ 0″		8′ 0″		6′ 0″	
Straight G.	0′ 0″		3′ 0″		0′ 0″		3′ 0″		0′ 0″		3′ 0″		0′ 0″		3′ 0″	
Straight H	0′ 0″		2′ 0″		0′ 0″		2′ 0″		0′ 0″		2′ 0″		0′ 0″		2′ 0″	
Lead rail AB	44′ 4 3/16″	50′ 6⅞″	47′ 4 3/16″	53′ 6⅞″	31′ 11 11/16″	36′ 10½″	34′ 11 11/16″	39′ 10½″	40′ 6¼″	46′ 2 7/16″	43′ 6¼″	49′ 2 7/16″	29′ 9 1/16″	34′ 3 13/16″	32′ 9 1/16″	37′ 3 13/16″
Lead rail CD	44′ 2 7/16″	50′ 4 15/16″	47′ 2 7/16″	53′ 4 15/16″	31′ 9″	36′ 7 9/16″	34′ 9″	39′ 7 9/16″	40′ 4¾″	46′ 0⅞″	43′ 4¾″	49′ 0⅞″	29′ 6¾″	34′ 1¼″	32′ 6¾″	37′ 1¼″
Note: For 45′ lead rail AB use these dimensions AB	45′ 0″				45′ 0″				45′ 0″							45′ 0″
Note: For 45′ lead rail AB use these dimensions CD	44′ 10¼″	44′ 9 13/16″	44′ 10¼″	44′ 9 13/16″		44′ 9¼″	44′ 9¾″	44′ 9¼″	44′ 10¾″	44′ 10 7/16″	44′ 10¾″	44′ 10 7/16″				44′ 9¾″
Note: For 45′ lead rail AB use these dimensions X	458.6018	376.3592	398.9889	294.9333		242.8732	244.8962	295.6536	439.0590	523.2154	552.4864	409.9870				283.1536
Note: For 45′ lead rail AB use these dimensions Y	66′ 10¾″	66′ 10 9/16″	63′ 10¾″	63′ 10 9/16″		66′ 9⅞″	63′ 10¼″	63′ 9¾″	61′ 11¼″	61′ 10 15/16″	58′ 11¼″	58′ 10 15/16″				58′ 10¼″
At B end of 45′ lead rail make straight .	1′ 0 9/16″	8′ 11½″	6′ 9 5/16″	16′ 9 5/16″		11′ 7 3/16″	11′ 3 13/16″	4′ 3¾″	9′ 4″	2′ 5⅞″	0′ 0″	8′ 11½″				10′ 2 1/16″
Note: For 30′ lead rail AB use these dimensions AB					30′ 0″								30′ 0″	30′ 0″	30′ 0″	
Note: For 30′ lead rail AB use these dimensions CD					29′ 9¼″								29′ 9¾″	29′ 9″	29′ 9¾″	
Note: For 30′ lead rail AB use these dimensions X					197.6960								240.5119	183.4454	181.6492	
Note: For 30′ lead rail AB use these dimensions Y					51′ 9¾″								46′ 10¼″	46′ 9½″	43′ 10¼″	
At B end of AB make straight . . .					2′ 9¾″									7′ 5 5/16″	7′ 8⅜″	
Toe spread	10″		5½″		1′ 1½″		7½″		10″		5½″		1′ 1½″		7½″	

Standard Equilateral Turnouts

With Split Switches



5′ 0″ between Tracks	15′ Split Switch								10′ Split Switch							
Number of frog	Number 8 frog				Number 6 frog				Number 8 frog				Number 6 frog			
Style of frog	Spring		Stiff		Spring		Stiff		Spring		Stiff		Spring		Stiff	
Gauge	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″	4′ 8½″	5′ 2¼″
Length over all L	137′ 6¼″	143′ 8¾″	137′ 6¼″	143′ 8¾″	105′ $2\frac{11}{16}$″	110′ $1\frac{5}{16}$″	105′ $2\frac{11}{16}$″	110′ $1\frac{5}{16}$″	128′ 8¼″	134′ 4⅜″	128′ 8¼″	134′ 4⅜″	98′ $0\frac{3}{16}$″	102′ 6¾″	98′ $0\frac{3}{16}$″	102′ 6¾″
Frog setting Y	66′ $3\frac{3}{16}$″	72′ $5\frac{11}{16}$″	66′ $3\frac{3}{16}$″	72′ $5\frac{11}{16}$″	53′ $9\frac{15}{16}$″	58′ $8\frac{9}{16}$″	53′ $9\frac{15}{16}$″	58′ $8\frac{9}{16}$″	57′ $5\frac{3}{16}$″	63′ $1\frac{5}{16}$″	57′ $5\frac{3}{16}$″	63′ $1\frac{5}{16}$″	46′ 7 $\frac{7}{16}$″	51′ 2″	46′ 7 $\frac{7}{16}$″	51′ 2″
Radius at switch end	924.0466	1053.6502	924.0466	1053.6502	463.3769	534.4318	463.3769	534.4318	995.6257	1135.2688	995.6257	1135.2688	482.3950	556.3674	482.3950	556.3674
Angle at switch end	2° 44′ 52″				3° 56′ 41″				2° 19′ 48″				3° 31′ 36″			
Radius at plain end	1012.3524				521.0741				1012.3524				521.0741			
Angle at plain end	3° 35′ 00″				4° 46′ 49″				3° 35′ 00″				4° 46′ 49″			
Length of frog arm E	7′ 0″		4′ 0″		7′ 0″		4′ 0″		7′ 0″		4′ 0″		7′ 0″		4′ 0″	
Length of frog arm F	8′ 0″		6′ 0″		8′ 0″		6′ 0″		8′ 0″		6′ 0″		8′ 0″		6′ 0″	
Straight G	0′ 0″		3′ 0″		0′ 0″		3′ 0″		0′ 0″		3′ 0″		0′ 0″		3′ 0″	
Straight H	0′ 0″		2′ 0″		0′ 0″		2′ 0″		0′ 0″		2′ 0″		0′ 0″		2′ 0″	
Lead rails AB	44′ $3\frac{5}{16}$″	50′ $5\frac{15}{16}$″	47′ $3\frac{5}{16}$″	53′ $5\frac{15}{16}$″	31′ $10\frac{7}{16}$″	36′ 9⅛″	34′ $10\frac{7}{16}$″	39′ 9⅛″	40′ $5\frac{7}{16}$″	46′ $1\frac{9}{16}$″	43′ $5\frac{7}{16}$″	49′ $1\frac{9}{16}$″	29′ 7⅞″	34′ 2½″	32′ 7⅞″	37′ 2½″
For 45′ lead rails AB use these dimensions AB	45′ 0″								45′ 0″							
For 45′ lead rails AB use these dimensions X	914.9883	754.9572	799.8630	591.8782					875.4130	1049.9567	1102.3074	823.1656				
For 45′ lead rails AB use these dimensions Y	66′ 11¾″		63′ 11¾″						61′ 11¾″		58′ 11¾″					
At B end of AB make straight	1′ $1\frac{13}{16}$″	8′ 10″	6′ $8\frac{1}{16}$″	16′ $7\frac{15}{16}$″					9′ $5\frac{3}{16}$″	2′ 4⅛″		11′ $6\frac{13}{16}$″				
For 30′ lead rails AB use these dimensions AB					30′ 0″								30′ 0″			
For 30′ lead rails AB use these dimensions X					397.4837	296.6920	291.9498	191.1581					478.5112	371 2049	365.2736	239.1858
For 30′ lead rails AB use these dimensions Y					51′ 11½″		48′ 11½″						46′ 11½″		43′ 11½″	
At B end of AB make straight					2′ 8″	9′ $7\frac{7}{16}$″	9′ 11¼″	16′ $10\frac{11}{16}$″						7′ 2⅜″	7′ 6⅝″	15′ $3\frac{13}{16}$″
M	$8\frac{9}{16}$″								$5\frac{11}{16}$″							
Toe spread	10″		5½″		1′ 1½″		7½″		10″		5½″		1′ 1½″		7½″	

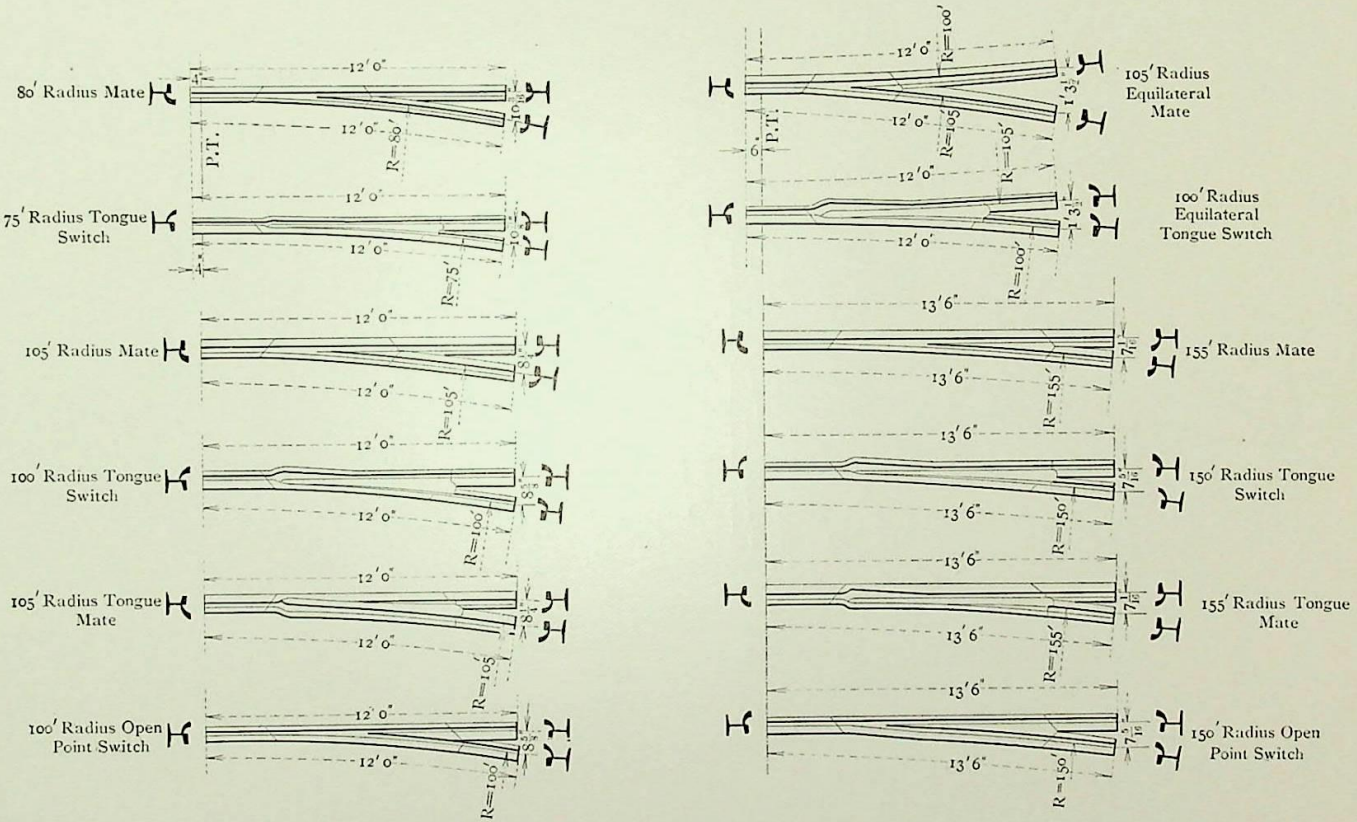
Standard Switches, Mates and Frogs

THE advantages of the use of "standards" in every branch of business is generally admitted. We therefore strongly urge and recommend the use of our standard switches, mates and frogs in street railway work wherever conditions will permit. The following diagrams show the lengths, radii and angles of our standards, which we trust may be of use to the purchaser and designer of street railway special work layouts.

We keep in stock standard switches, mates and frogs of the most prevalent sections and heights of rails.

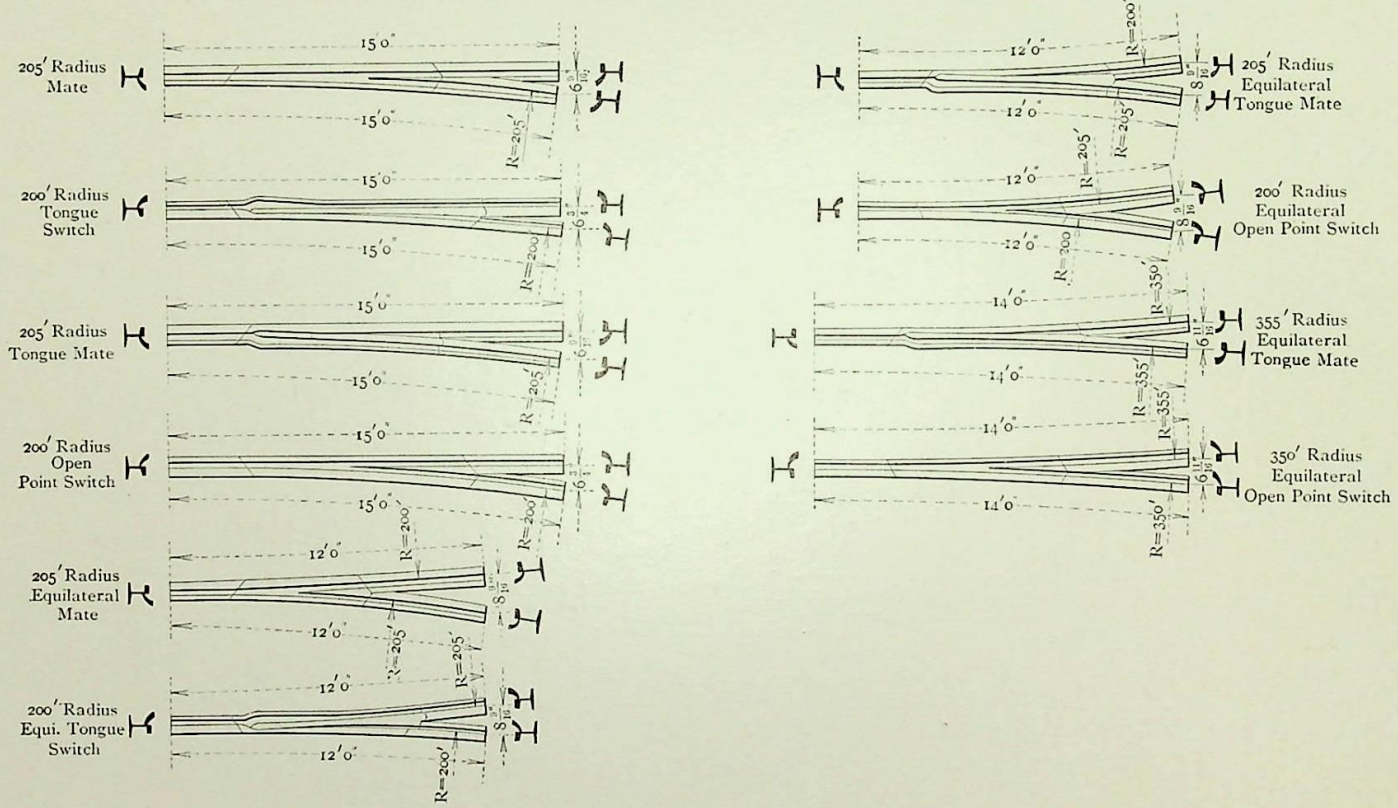
Dimensions of Standard Switch Pieces

For Manganese Steel and Integral Construction



Dimensions of Standard Switch Pieces

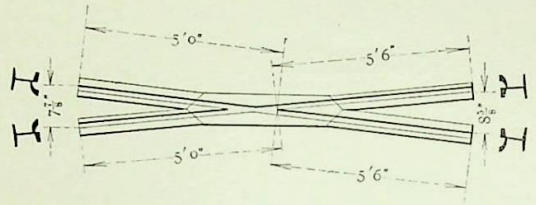
For Manganese Steel and Integral Construction


205′ Radius Mate
200′ Radius Tongue Switch
205′ Radius Tongue Mate
200′ Radius Open Point Switch
205′ Radius Equilateral Mate
200′ Radius Equi. Tongue Switch
205′ Radius Equilateral Tongue Mate
200′ Radius Equilateral Open Point Switch
355′ Radius Equilateral Tongue Mate
350′ Radius Equilateral Open Point Switch

Dimensions of Standard Frogs

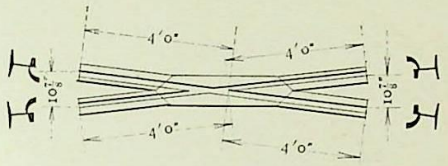
For Manganese Steel and Integral Construction

7°30′



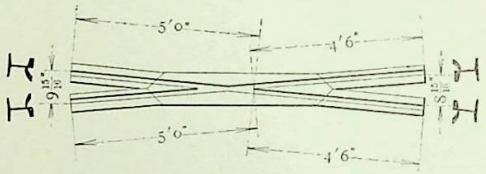
Spread in three feet = $4\frac{11}{16}$ Inches.

13°0′



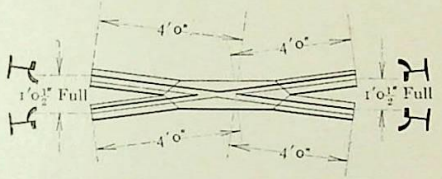
Spread in three feet = 8⅛ Inches.

9°30′



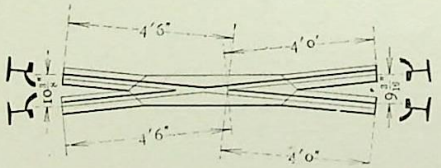
Spread in three feet = $5\frac{15}{16}$ Inches.

15°0′



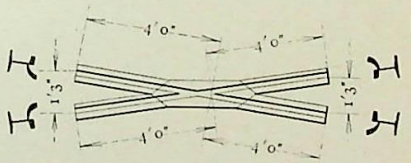
Spread in three feet = 9⅜ Inches.

11°0′



Spread in three feet = 6⅞ Inches.

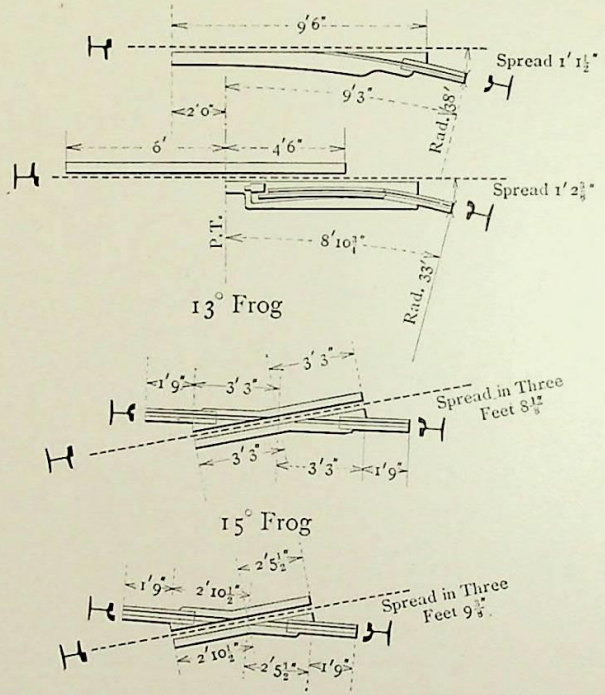
18°0′

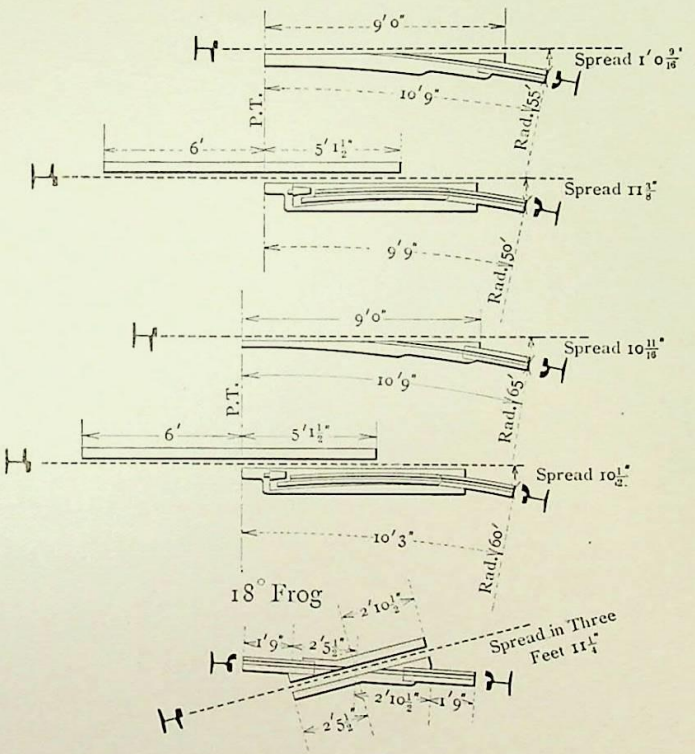


Spread in three feet = 11¼ Inches.

Dimensions of Standard Unbroken Main Line Switch and Frog Pieces

For 6-inch, 7-inch and 9-inch high Construction





Approximate Weights of Standard Switches, Mates and Frogs Girder Rail Work, for Street Railways

Integral Construction

	6″ High	7″ High	9″ High
Tongue switches: Lateral, 75′, 100′, 150′, 200′ radius; equilateral, 100′, 200′ radius	1100 lbs.	1200 lbs.	1375 lbs.
Mates: Lateral, 80′, 105′ radius; equilateral, 105′ radius	1000 lbs.	1100 lbs.	1275 lbs.
Mates: Lateral, 155′, 205′ radius; equilateral, 205′ radius	1100 lbs.	1200 lbs.	1375 lbs.
Open point switches: Lateral, 200′ radius; equilateral, 200′, 350′ radius	1100 lbs.	1200 lbs.	1375 lbs.
Tongue mates: Lateral, 205′ radius; equilateral, 205′, 355′ radius	1100 lbs.	1200 lbs.	1375 lbs.
Frogs: 6° to 9° 59′	1050 lbs.	1100 lbs.	1200 lbs.
Frogs: 10° to 13° 59′	950 lbs.	1000 lbs.	1100 lbs.
Frogs: 14° and over	900 lbs.	950 lbs.	1000 lbs.
Crossings: 90°	2000 lbs.	2200 lbs.	2300 lbs.

Manganese Steel Center Construction

Tongue switches: Lateral, 75′, 100′, 150′, 200′ radius; equilateral, 100′, 200′ radius	1400 lbs.	1500 lbs.	1600 lbs.
Mates: Lateral, 80′, 105′ radius; equilateral, 105′ radius	1250 lbs.	1300 lbs.	1350 lbs.
Mates: Lateral, 155′, 205′ radius; equilateral, 205 radius	1300 lbs.	1400 lbs.	1500 lbs.
Open point switches: Lateral, 200′ radius; equilateral, 200′, 350′ radius	1300 lbs.	1400 lbs.	1500 lbs.
Tongue mates: Lateral, 205′ radius; equilateral, 205′, 355′ radius	1400 lbs.	1500 lbs.	1600 lbs.
Frogs: 6° to 9° 59′	1000 lbs.	1100 lbs.	1200 lbs.
Frogs: 10° to 13° 59′	900 lbs.	950 lbs.	1050 lbs.
Frogs: 14° and over	850 lbs.	900 lbs.	1000 lbs.
Crossings: 90°	2200 lbs.	2750 lbs.	3100 lbs.

Unbroken Main Line Construction

Tongue switches with guard: Lateral, 33′. 50′ 60′ radius	1250 lbs.	1400 lbs.	1675 lbs.
Mates: Lateral, 38′, 55′, 65′ radius	725 lbs.	800 lbs.	950 lbs.
Frogs: 13°, 15°, 18°	1100 lbs.	1200 lbs.	1350 lbs.

Spiral Curves

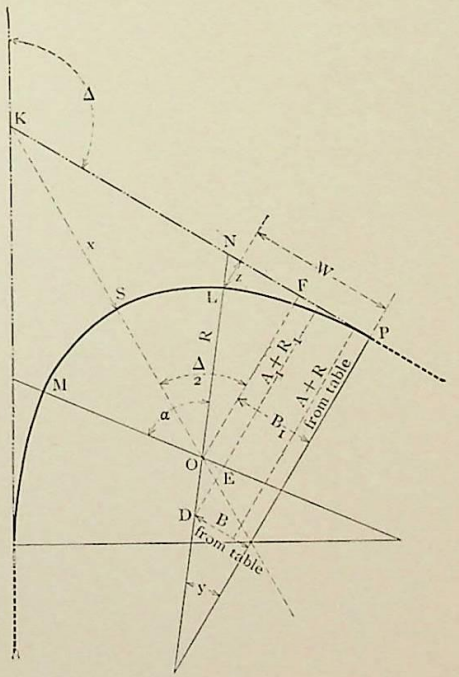
THE introduction of easement or spiral curves into street railway special work layouts, thus following the best steam railroad practice, has produced new difficulties in the designing of such layouts where the work is usually and necessarily confined within narrow limits. The advantages to be gained by the easements at the ends of curves are unquestioned, but the narrow confines of city streets referred to make it impossible to utilize the standard easements generally established for steam railroads. It has therefore been our aim to devise a simple and thoroughly practical system of spirals for use in street railway curves, which we submit in the following diagrams.

We call particular attention to the possibility of introducing switches into the existing plain ends of spiral curves, *i. e.*, changing a plain curve to a branch-off without disturbing the alignment.

The Wharton Standard Street Railway Spirals

THE Wharton spirals as illustrated on the following sheets are derived from one common base, represented in spiral 1. The other spirals are derived from it by multiplying the functions of this spiral by the figures indicated for the number of the spirals, *i. e.*, by 1½ for spiral No. 1½, by 2 for spiral No. 2 and by 3 for spiral No. 3. It is recommended to use: Spiral No. 1 for curves with central radius not exceeding 62′ 6″; spiral No. 1½ for curves with central radius not exceeding 112′ 6″; spiral No. 2 for curves with central radius not exceeding 200′; spiral No. 3 for curves with central radius not exceeding 500′.

The switch spirals are derived from the plain end spirals, and the plain end spirals are so arranged that switches can be set into plain ends of curves at any time without changing the lines, *i. e.*, a 100′ rad. switch in spiral No. 1, a 150′ rad. switch in spiral No. 1½, and a 200′ rad. switch in spiral No. 2. Spiral No. 3 is of too long an initial radius to admit a switch. The diagrams show the position which the switch takes in relation to the *PC* of the plain end spiral. Curves with switch ends should be laid out as if the ends were plain and switches set in afterwards.



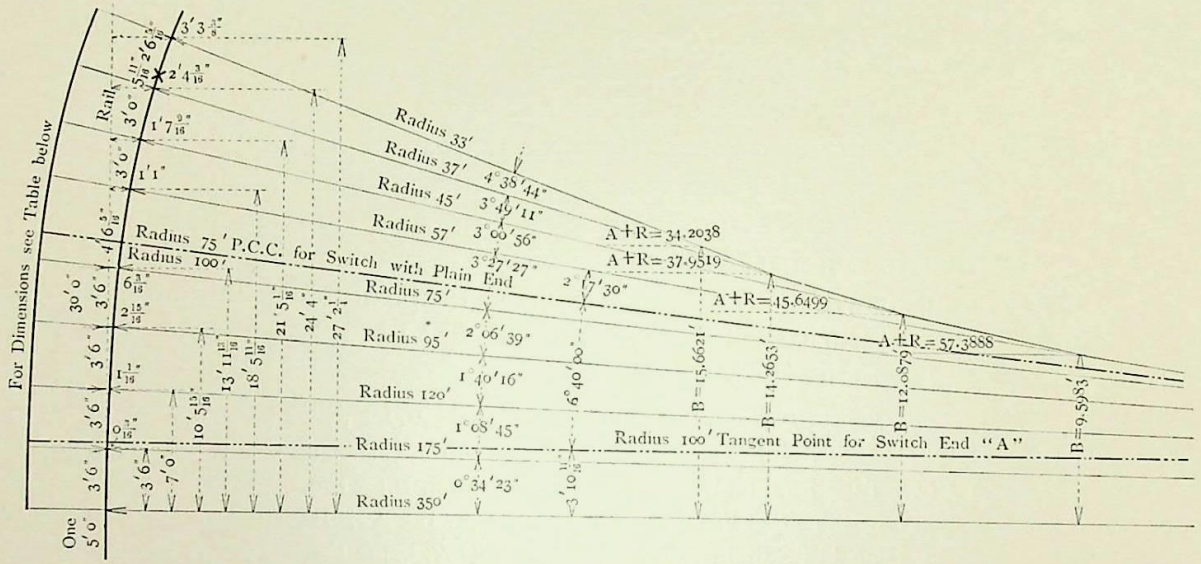
To lay out Spiral Curve with given Central Radius. In right angle triangle DOE, $y=$ total deflection angle of spiral, $DO=$ the difference between central radius and the smallest radius of spiral. Calculate DE and EO. Take from table the distance in column B for the smallest radius and add OE, thus obtaining the B_1. From the value given in the A + R column for the smallest spiral radius in same table, deduct DE. B_1 and A_1+R_1 being the co-ordinates of central radius center. In right angle triangle OFK, having angle $\frac{\Delta}{2}$ and side A_1+R_1, find FK, which added to B gives tangent KP. From point P lay off spiral by means of the co-ordinates given on plan of spiral. The last point thus located is L. Locate the other end in the same way, ending at point M. From points L and M, determine center O and draw in central radius.

To Substitute Spiral Curves for Circular Curves of known Radius without changing Exsecant X. Select a spiral for a radius somewhat smaller than the radius of the plain circular curve. Calculate exsecant X for plain circular curve, get distance Z and total deflection angle from table. Calculate new central radius of special curve as follows:

$$R=\frac{X\cos\frac{\Delta}{2}-Z}{\cos y-\cos\frac{\Delta}{2}}=\frac{X\cos\frac{\Delta}{2}-Z}{2\sin(y+\frac{1}{4}a)\sin\frac{1}{4}a}$$

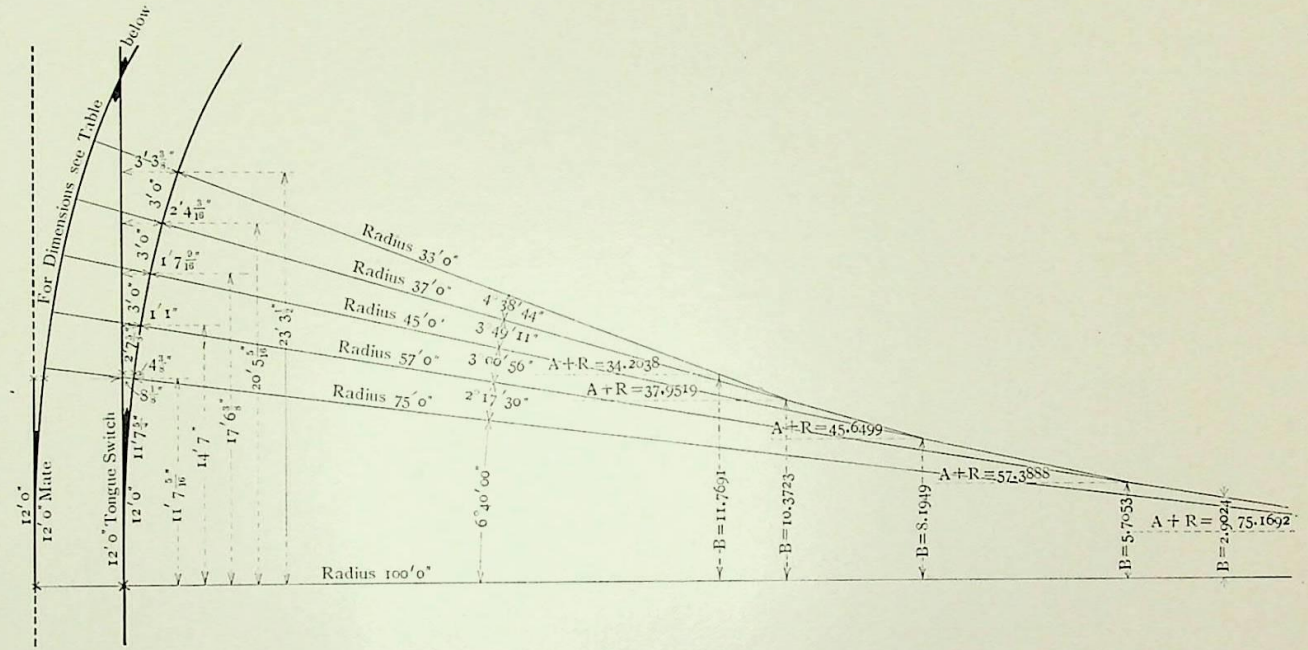
Having thus obtained the central radius proceed as above.

Wharton Standard Transition, Plain End No. 1



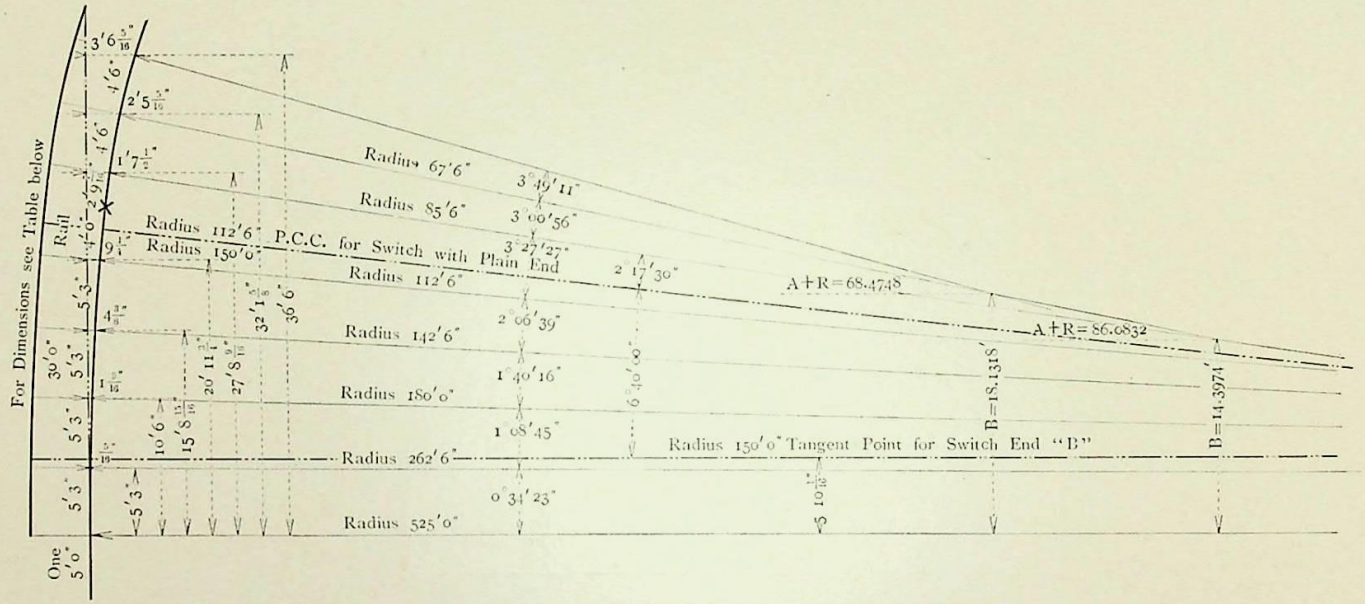
Inside Radius	Deflection Angles		Co-ordinates of Centers		Inside Arcs		Outside Arcs Gauge 4′ 8½″		Outside Arcs Gauge 4′ 10″		Outside Arcs Gauge 5′ 0″		Outside Arcs Gauge 5′ 2″		Outside Arcs Gauge 5′ 2¼″	
	Partial	Total	B	A + R	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total
350′	0° 34′ 23″	0° 34′ 23″	0.0000′	350.0000′	3.5000′	3.5000′	3′ 6 9/16″	3′ 6 9/16″	3′ 6 9/16″	3′ 6 9/16″	3′ 6 5/8″	3′ 6 5/8″	3′ 6 5/8″	3′ 6 5/8″	3′ 6 5/8″	3′ 6 5/8″
175	1 08 45	1 43 08	1.7502	175.0088	3.5000	7.0000	3 7 1/8	7 1 1/8	3 7 3/16	7 1 3/16	3 7 1/4	7 1 1/4	3 7 1/4	7 1 1/4	3 7 1/4	7 1 1/4
120	1 40 16	3 23 24	3.3999	120.0335	3.5000	10.5000	3 7 5/8	10 9 5/16	3 7 11/16	10 9 7/16	3 7 3/4	10 9 5/8	3 7 13/16	10 9 11/16	3 7 13/16	10 9 11/16
95	2 06 39	5 30 03	4.8782	95.0772	3.5000	14.0000	3 8 1/8	14 5 7/16	3 8 1/8	14 5 9/16	3 8 3/16	14 5 3/4	3 8 1/4	14 5 15/16	3 8 5/16	14 6
75	3 27 27	8 57 30	6.7954	75.1692	4.5258	18.5258	4 9 11/16	19 3 1/8	4 9 13/16	19 3 3/8	4 9 15/16	19 3 11/16	4 10 1/16	19 4		
57	3 00 56	11 58 26	9.5983	57.3888	3.0000	21.5258	3 3	22 6 1/8	3 3 1/16	22 6 7/16	3 3 1/8	22 6 11/16	3 3 1/4	22 7 1/4	3 3 1/4	22 7 5/16
45	3 49 11	15 47 37	12.0879	45.6499	3.0000	24.5258	3 3 3/4	25 9 7/8	3 3 7/8	25 10 5/16	3 4	25 10 13/16	3 4 1/8	25 11 3/8	3 4 1/8	25 11 7/16
37	4 38 44	20 26 21	14.2653	37.9519	3.0000	27.5258	3 4 9/16	29 2 7/16	3 4 11/16	29 3	3 4 7/8	29 3 11/16	3 5 1/16	29 4 7/16	3 5 1/16	29 4 1/2
33			15.6621	34.2038												

Wharton Standard Transition, Tongue Switch End A



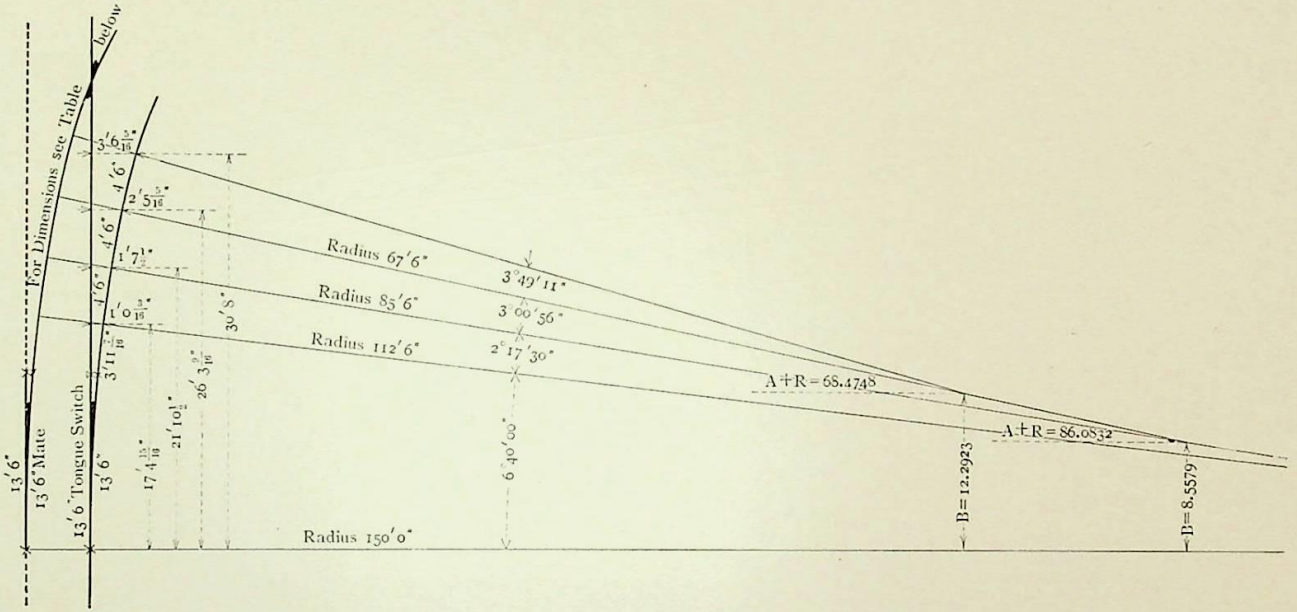
Inside Radius	Deflection Angles		Co-ordinates of Centers		Inside Arcs		Outside Arcs Gauge 4′ 8½″		Outside Arcs Gauge 4′ 10″		Outside Arcs Gauge 5′ 0″		Outside Arcs Gauge 5′ 2″		Outside Arcs Gauge 5′ 2¼″	
	Partial	Total	B	A + R	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total
100′	6° 40′ 00″	6° 40′ 00″	0.0000′	100.0000′	11.6355′	11.6355′	12′ 2 3/16″	12′ 2 3/16″	12′ 2 3/8″	12′ 2 3/8″	12′ 2 5/8″	12′ 2 5/8″	12′ 2 13/16″	12′ 2 13/16″	12′ 2 7/8″	12′ 2 7/8″
75	2 17 30	8 57 30	2.9024	75.1692	3.0000	14.6355	3 2¼	15 4 7/16	3 2 5/16	15 4 11/16	3 2 3/8	15 5	3 2½	15 5 5/16	3 2½	15 5 3/8
57	3 00 56	11 58 26	5.7053	57.3888	3.0000	17.6355	3 3	18 7 7/16	3 3 1/16	18 7¾	3 3⅛	18 8⅛	3 3¼	18 8 9/16	3 3¼	18 8 5/8
45	3 49 11	15 47 37	8.1949	45.6499	3.0000	20.6355	3 3¾	21 11 3/16	3 3⅞	21 11 5/8	3 4	22 0⅛	3 4⅛	22 0 11/16	3 4⅛	22 0¾
37	4 38 44	20 26 21	10.3723	37.9519	3.0000	23.6355	3 4 9/16	25 3¾	3 4 11/16	25 4 5/16	3 4⅞	25 5	3 5 1/16	25 5¾	3 5 1/16	25 5 13/16
33	. . . . .	. . . . .	11.7691	34.2038												

Wharton Standard Transition, Plain End No. 1 1/2



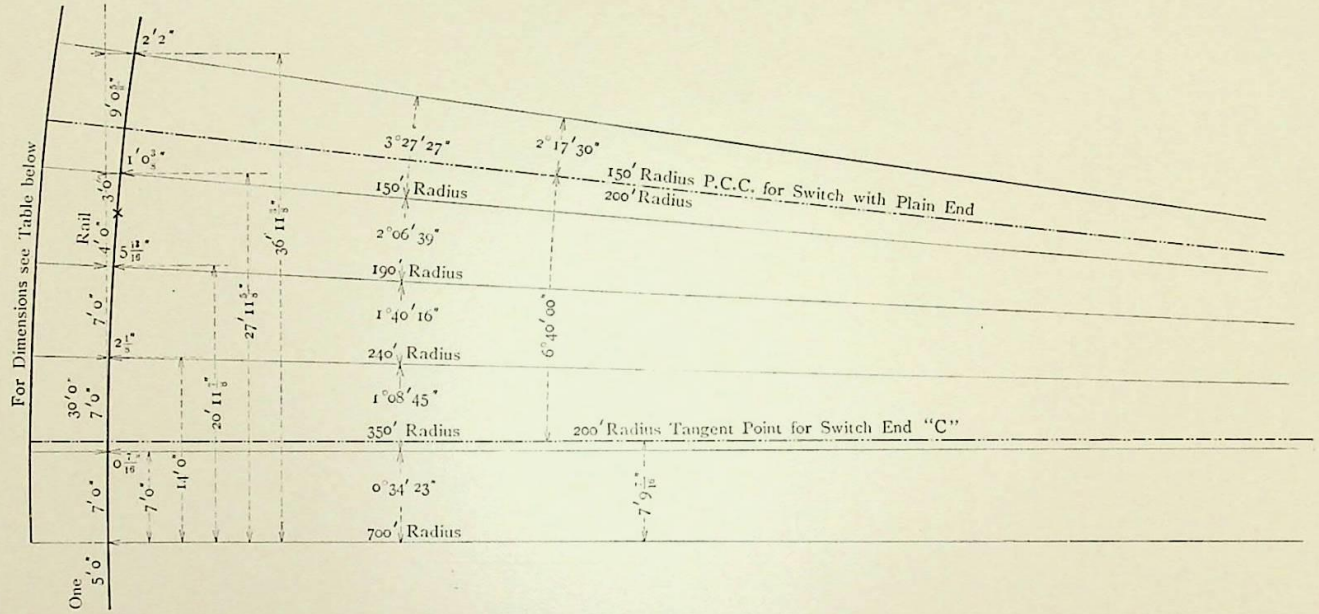
Inside Radius	Deflection Angles		Co-ordinates of Centers		Inside Arcs		Outside Arcs Gauge 4′ 8½″		Outside Arcs Gauge 4′ 10″		Outside Arcs Gauge 5′ 0″		Outside Arcs Gauge 5′ 2″		Outside Arcs Gauge 5′ 2¼″	
	Partial	Total	B	A + R	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total
525′0″	0° 34′ 23″	0° 34′ 23″	0.0000′	525.0000′	5′ 3″	5′ 3″	5′ 3 1/16″	5′ 3 1/16″	5′ 3 1/16″	5′ 3 1/16″	5′ 3 5/16″	5′ 3 5/16″	5′ 3 5/16″	5′ 3 5/16″	5′ 3 5/16″	5′ 3 5/16″
262 6	1 08 45	1 43 08	2.6253	262.5132	5 3	10 6	5 4 1/16	10 7 1/16	5 4 1/16	10 7 1/16	5 4 3/16	10 7 3/16	5 4 1/4	10 7 3/8	5 4 1/4	10 7 3/8
180 0	1 40 16	3 23 24	5.0998	180.0502	5 3	15 9	5 4 5/8	16 0 1/16	5 4 11/16	16 0 1/16	5 4 3/4	16 0 1/16	5 4 13/16	16 0 11/16	5 4 13/16	16 0 11/16
142 6	2 06 39	5 30 03	7.3173	142.6158	5 3	21 0	5 5 1/16	21 5 1/16	5 5 1/16	21 5 1/16	5 5 3/16	21 5 3/16	5 5 1/4	21 5 1/16	5 5 5/16	21 6
112 6	3 27 27	8 57 30	10.1931	112.7538	6 9 7/16	27 9 7/16	7 0 13/16	28 6 1/4	7 0 15/16	28 6 1/2	7 1 1/16	28 6 5/16	7 1 3/16	28 7 1/8	7 1 5/16	28 7 7/16
85 6	3 00 56	11 58 26	14.3974	86.0832	4 6	32 3 7/16	4 9	33 3 1/4	4 9 1/16	33 3 5/16	4 9 1/8	33 3 7/16	4 9 1/4	33 4 3/8	4 9 1/4	33 4 7/16
67 6	3 49 11	15 47 37	18.1318	68.4748	4 6	36 9 7/16	4 9 3/4	38 1	4 9 7/8	38 1 1/16	4 10	38 1 1/16	4 10 1/8	38 2 1/2	4 10 1/8	38 2 9/16

Wharton Standard Transition, Tongue Switch End B



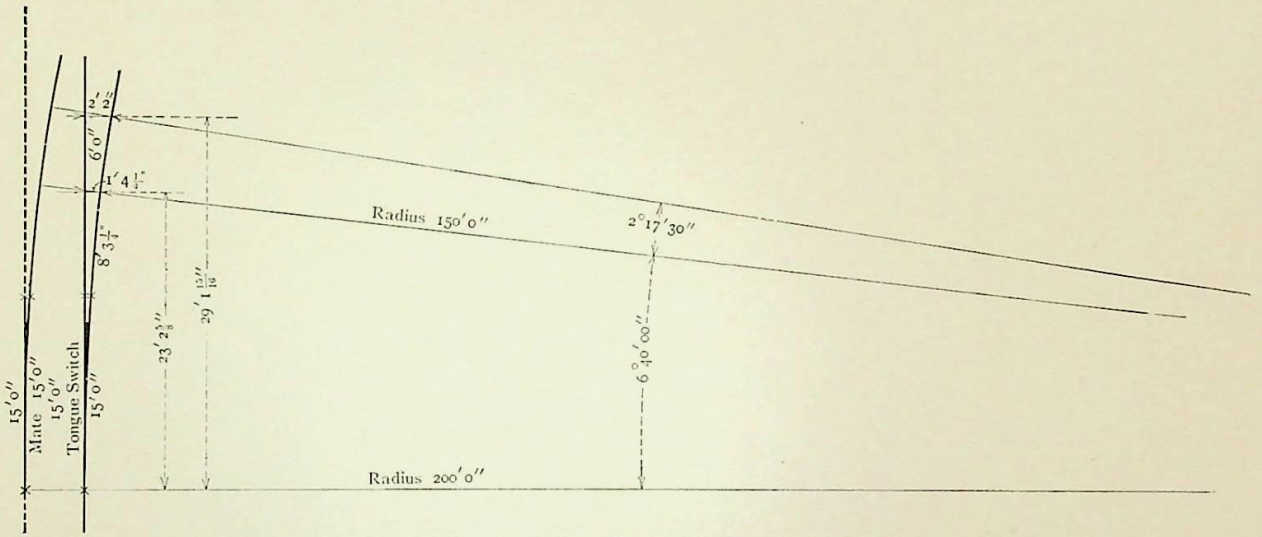
Inside Radius	Deflection Angles		Co-ordinates of Centers		Inside Arcs		Outside Arcs Gauge 4′ 8½″		Outside Arcs Gauge 4′ 10″		Outside Arcs Gauge 5′ 0″		Outside Arcs Gauge 5′ 2″		Outside Arcs Gauge 5′ 2¼″	
	Partial	Total	B	A + R	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total
150′ 0″	6° 40′ 0″	6° 40′ 00″	0.0000′	150.0000′	17′ 5 7/16″	17′ 5 7/16″	18′ 0″	18′ 0″	18′ 0 3/16″	18′ 0 3/16″	18′ 0 7/16″	18′ 0 7/16″	18′ 0 5/8″	18′ 0 5/8″	18′ 0 11/16″	18′ 0 11/16″
112 6	2 17 30	8 57 30	4.3536	112.7538	4 6	21 11 7/16	4 8¼	22 8¼	4 8 5/16	22 8½	4 8⅜	22 8 13/16	4 8½	22 9⅛	4 8½	22 9 3/16
85 6	3 00 56	11 58 26	8.5579	86.0832	4 6	26 5 7/16	4 9	27 5¼	4 9 1/16	27 5 9/16	4 9⅛	27 5 15/16	4 9¼	27 6⅜	4 9¼	27 6 7/16
67 6	3 49 11	15 47 37	12.2923	68.4748	4 6	30 11 7/16	4 9¾	32 3	4 9⅞	32 3 1/16	4 10	32 3 5/16	4 10⅛	32 4½	4 10⅛	32 4 9/16

Wharton Standard Transition, Plain End No. 2



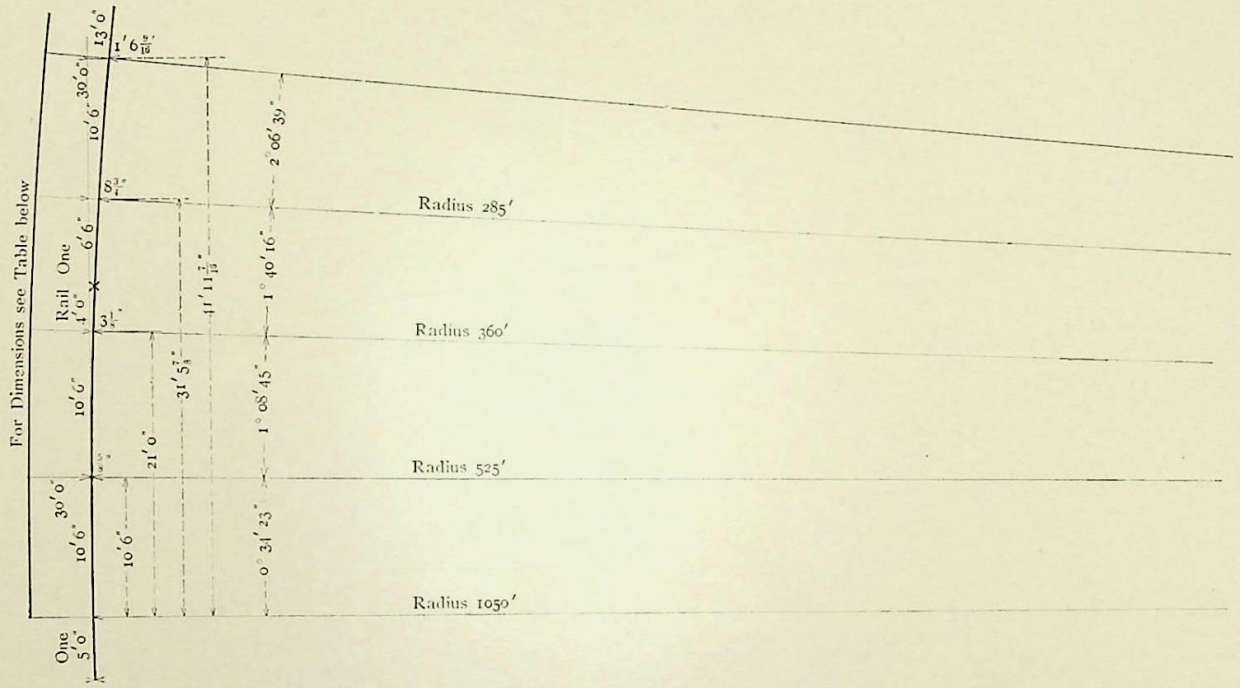
Inside Radius	Deflection Angles		Co-ordinates of Centers		Inside Arcs		Outside Arcs Gauge 4′ 8½″		Outside Arcs Gauge 4′ 10″		Ousside Arcs Gauge 5′ 0″		Outside Arcs Gauge 5′ 2″		Outside Arcs Gauge 5′ 2¼″	
	Partial	Total	B	A + R	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total
700′	0° 34′ 23″	0° 34′ 23″	0.0000′	700.0000′	7.0012′	7.0012′	7′ 0 9/16″	7′ 0 9/16″	7′ 0 9/16″	7′ 0 9/16″	7′ 0 5/8″	7′ 0 5/8″	7′ 0 5/8″	7′ 0 5/8″	7′ 0 5/8″	7′ 0 5/8″
350	1 08 45	1 43 08	3.5005	350.0176	6.9995	14.0007	7 1 1/8	14 1 1/16	7 1 3/16	14 1 1/4	7 1 3/16	14 1 1/8	7 1 1/4	14 1 7/8	7 1 1/4	14 1 7/8
240	1 40 16	3 23 24	6.8000	240.0671	6.9999	21.0006	7 1 5/8	21 3 5/16	7 1 11/16	21 3 7/16	7 1 3/4	21 3 9/16	7 1 13/16	21 3 11/16	7 1 13/16	21 3 11/16
190	2 06 39	5 30 03	9.7566	190.1546	6.9998	28.0004	7 2 1/16	28 5 3/8	7 2 1/8	28 5 1/16	7 2 3/16	28 5 1/4	7 2 1/4	28 5 1/16	7 2 5/16	28 6
150	3 27 27	8 57 30	13.5910	150.3388	9.0517	37.0521	9 4 1/16	37 9 7/16	9 4 1/8	37 9 11/16	9 4 1/4	37 10	9 4 3/8	37 10 5/16	9 4 3/8	37 10 3/8

Wharton Standard Transition, Tongue Switch End C



Inside Radius	Deflection Angles		Co-ordinates of Centers		Inside Arcs		Outside Arcs Gauge 4′ 8½″		Outside Arcs Gauge 4′ 10″		Outside Arcs Gauge 5′ 0″		Outside Arcs Gauge 5′ 2″		Outside Arcs Gauge 5′ 2¼″	
	Partial	Total	B	A + R	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total
200′	6° 40′ 00″	6° 40′ 00″	0.0000′	200.0000′	23′ 3¼″	23′ 3¼″	23′ 9 1/16″	23′ 9 1/16″	23′ 10″	23′ 10″	23′ 10¼″	23′ 10¼″	23′ 10 7/16″	23′ 10 7/16″	23′ 10½″	23′ 10½″
150	2 17 30	8 57′ 30″	5.8048	150.3388	6 0	29 3¼	6 2¼	30 0 1/16	6 2 5/16	30 0 5/16	6 2⅜	30 0⅝	6 2½	30 0 15/16	6 2½	30 1

Wharton Standard Transition, Plain End No. 3



Inside Radius	Deflection Angles		Co-ordinates of Centers		Inside Arcs		Outside Arcs Gauge 4′ 8½″		Outside Arcs Gauge 4′ 10″		Outside Arcs Gauge 5′ 0″		Outside Arcs Gauge 5′ 2″		Outside Arcs Gauge 5′ 2¼″	
	Partial	Total	B	A+R	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total
1050′	0° 34′ 23″	0° 34′ 23″	0.0000′	1050.0000′	10′ 6″	10′ 6″	10′ 6 9/16″	10′ 6 9/16″	10′ 6 9/16″	10′ 6 9/16″	10′ 6 5/8″	10′ 6 5/8″	10′ 6 5/8″	10′ 6 5/8″	10′ 6 5/8″	10′ 6 5/8″
525	1 08 45	1 43 08	5.2506	525.0264	10 6	21 0	10 7 1/8	21 1 11/16	10 7 3/16	21 1 3/4	10 7 3/16	21 1 13/16	10 7 1/4	21 1 7/8	10 7 1/4	21 1 7/8
360	1 40 16	3 23 24	10.1998	360.1005	10 6	31 6	10 7 5/8	31 9 5/16	10 7 11/16	31 9 7/16	10 7 3/4	31 9 1/16	10 7 13/16	31 9 11/16	10 7 13/16	31 9 11/16
285	2 06 39	5 30 03	14.6346	285.2316	10 6	42 0	10 8 1/16	42 5 3/8	10 8 1/8	42 5 9/16	10 8 3/16	42 5 3/4	10 8 1/4	42 5 15/16	10 8 5/16	42 6

Decimal Equivalents of Vulgar Fractions

Each decimal is the part of an inch corresponding to the fraction of an inch given opposite to it in the first column. Also, each decimal is the part of a foot corresponding to the inches and fractions thereof given opposite to it in the third column.

	.0052	1/16	11/64	.171875	2 1/16		.3385	4 1/16		.5052	6 1/16	43/64	.671875	8 1/16		.8385	10 1/16
	.0104	1/8				11/32	.34375	4 1/8		.5104	6 1/8				27/32	.84375	10 1/8
1/64	.015625	3/16		.1771	2 1/8				33/64	.515625	6 3/16		.6771	8 1/8			
				.1823	2 3/16		.3490	4 3/16					.6823	8 3/16		.8490	10 3/16
	.0208	1/4	3/16	.1875	2 1/4		.3542	4 1/4		.5208	6 1/4	11/16	.6875	8 1/4		.8542	10 1/4
	.0260	5/16				23/64	.359375	4 5/16		.5260	6 5/16				55/64	.859375	10 5/16
1/32	.03125	3/8		.1927	2 5/16				17/32	.53125	6 3/8		.6927	8 5/16			
				.1979	2 3/8		.3646	4 3/8					.6979	8 3/8		.8646	10 3/8
	.0364	7/16	13/64	.203125	2 7/16		.3698	4 7/16		.5364	6 7/16	45/64	.703125	8 7/16		.8698	10 7/16
	.0417	1/2				3/8	.3750	4 1/2		.5417	6 1/2				7/8	.8750	10 1/2
3/64	.046875	9/16		.2083	2 1/2				35/64	.546875	6 9/16		.7083	8 1/2			
				.2135	2 9/16		.3802	4 9/16					.7135	8 9/16		.8802	10 9/16
	.0521	5/8	7/32	.21875	2 5/8		.3854	4 5/8		.5521	6 5/8	23/32	.71875	8 5/8		.8854	10 5/8
	.0573	11/16				25/64	.390625	4 11/16		.5573	6 11/16				57/64	.890625	10 11/16
1/16	.0625	3/4		.2240	2 11/16				9/16	.5625	6 3/4		.7240	8 11/16			
				.2292	2 3/4		.3958	4 3/4					.7292	8 3/4		.8958	10 3/4
	.0677	13/16	15/64	.234375	2 13/16		.4010	4 13/16		.5677	6 13/16	47/64	.734375	8 13/16		.9010	10 13/16
	.0729	7/8				13/32	.40625	4 7/8		.5729	6 7/8				29/32	.90625	10 7/8
5/64	.078125	15/16		.2395	2 7/8				37/64	.578125	6 15/16		.7396	8 7/8			
				.2448	2 15/16		.4114	4 15/16					.7448	8 15/16		.9115	10 15/16
	.0833	1	1/4	.2500	3		.4167	5		.5833	7	3/4	.7500	9		.9167	11
	.0885	1 1/16				27/64	.421875	5 1/16		.5885	7 1/16				59/64	.921875	11 1/16
3/32	.09375	1 1/8		.2552	3 1/16				19/32	.59375	7 1/8		.7552	9 1/16			
				.2604	3 1/8		.4271	5 1/8					.7604	9 1/8		.9271	11 1/8
			17/64	.265625	3 3/16		.4323	5 3/16		.5990	7 3/16	49/64	.765625	9 3/16		.9323	11 3/16
	.0990	1 3/16				7/16	.4375	5 1/4		.6042	7 1/4				15/16	.9375	11 1/4
	.1042	1 1/4		.2708	3 1/4				39/64	.609375	7 5/16		.7708	9 1/4			
7/64	.109375	1 5/16		.2760	3 5/16		.4427	5 5/16					.7760	9 5/16		.9427	11 5/16
			9/32	.28125	3 3/8		.4479	5 3/8		.6146	7 3/8	25/32	.78125	9 3/8		.9479	11 3/8
	.1146	1 3/8				29/64	.453125	5 7/16		.6198	7 7/16				61/64	.953125	11 7/16
	.1198	1 7/16		.2865	3 7/16				5/8	.6250	7 1/2		.7865	9 7/16			
1/8	.1250	1 1/2		.2917	3 1/2		.4583	5 1/2					.7917	9 1/2		.9583	11 1/2
			19/64	.296875	3 9/16		.4635	5 9/16		.6302	7 9/16	51/64	.796875	9 9/16		.9635	11 9/16
	.1302	1 9/16				15/32	.46875	5 5/8		.6354	7 5/8				31/32	.96875	11 5/8
	.1354	1 5/8		.3021	3 5/8				41/64	.640625	7 11/16		.8021	9 5/8			
9/64	.140625	1 11/16		.3073	3 11/16		4740	5 11/16					.8073	9 11/16			
			5/16	.3125	3 3/4		.4792	5 3/4		.6158	7 3/4	13/16	.8125	9 3/4		.9740	11 11/16
	.1458	1 3/4				31/64	.484375	5 13/16		.6510	7 13/16					.9792	11 3/4
	.1510	1 13/16		.3177	3 13/16				21/32	.65625	7 7/8		.8177	9 13/16	63/64	.984375	11 13/16
5/32	.15625	1 7/8		.3229	3 7/8								.8229	9 7/8			
			21/64	.328125	3 15/16		.4896	5 7/8				53/64	.828125	9 15/16		.9896	11 7/8
	.1615	1 15/16					.4948	5 15/16		.6615	7 15/16					.9948	11 15/16
	.1667	2		.3333	4	1/2	.5000	6		.6667	8		.8333	10	1	1.0000	12

Lengths of Circular Arcs for the Radius 1

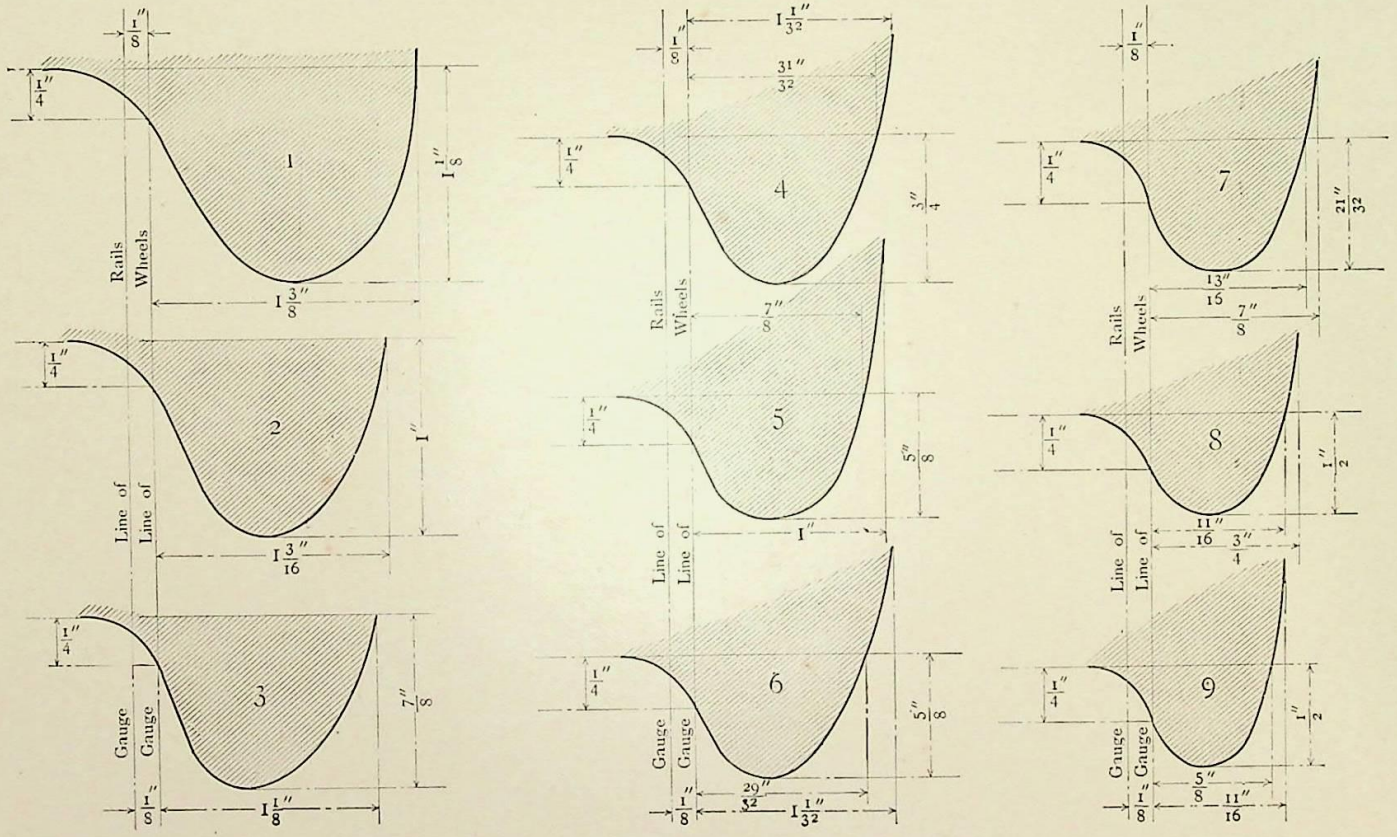
Degrees

0°	0.0000000	30°	0.5235988	60°	1.0471976	90°	1.5707963	120°	2.0943951	150°	2.6179939
1	0.0174533	31	0.5410521	61	1.0646508	91	1.5882496	121	2.1118484	151	2.6354472
2	0.0349066	32	0.5585054	62	1.0821041	92	1.6057029	122	2.1293017	152	2.6529005
3	0.0523599	33	0.5759587	63	1.0995574	93	1.6231562	123	2.1467550	153	2.6703538
4	0.0698132	34	0.5934119	64	1.1170107	94	1.6406095	124	2.1642083	154	2.6878070
5	0.0872665	35	0.6108652	65	1.1344640	95	1.6580628	125	2.1816616	155	2.7052603
6	0.1047198	36	0.6283185	66	1.1519173	96	1.6755161	126	2.1991149	156	2.7227136
7	0.1221730	37	0.6457718	67	1.1693706	97	1.6929694	127	2.2165682	157	2.7401669
8	0.1396263	38	0.6632251	68	1.1868239	98	1.7104227	128	2.2340214	158	2.7576202
9	0.1570796	39	0.6806784	69	1.2042772	99	1.7278760	129	2.2514747	159	2.7750735
10	0.1745329	40	0.6981317	70	1.2217305	100	1.7453293	130	2.2689280	160	2.7925268
11	0.1919862	41	0.7155850	71	1.2391838	101	1.7627825	131	2.2863813	161	2.8099801
12	0.2094395	42	0.7330383	72	1.2566371	102	1.7802358	132	2.3038346	162	2.8274334
13	0.2268928	43	0.7504916	73	1.2740904	103	1.7976891	133	2.3212879	163	2.8448867
14	0.2443461	44	0.7679449	74	1.2915436	104	1.8151424	134	2.3387412	164	2.8623400
15	0.2617994	45	0.7853982	75	1.3089969	105	1.8325957	135	2.3561945	165	2.8797933
16	0.2792527	46	0.8028515	76	1.3264502	106	1.8500490	136	2.3736478	166	2.8972466
17	0.2967060	47	0.8203047	77	1.3439035	107	1.8675023	137	2.3911011	167	2.9146999
18	0.3141593	48	0.8377580	78	1.3613568	108	1.8849556	138	2.4085544	168	2.9321531
19	0.3316126	49	0.8552113	79	1.3788101	109	1.9024089	139	2.4260077	169	2.9496064
20	0.3490659	50	0.8726646	80	1.3962634	110	1.9198622	140	2.4434610	170	2.9670597
21	0.3665191	51	0.8901179	81	1.4137167	111	1.9373155	141	2.4609142	171	2.9845130
22	0.3839724	52	0.9075712	82	1.4311700	112	1.9547688	142	2.4783675	172	3.0019663
23	0.4014257	53	0.9250245	83	1.4486233	113	1.9722221	143	2.4958208	173	3.0194196
24	0.4188790	54	0.9424778	84	1.4660766	114	1.9896753	144	2.5132741	174	3.0368729
25	0.4363323	55	0.9599311	85	1.4835299	115	2.0071286	145	2.5307274	175	3.0543262
26	0.4537856	56	0.9773844	86	1.5009832	116	2.0245819	146	2.5481807	176	3.0717795
27	0.4712389	57	0.9948377	87	1.5184364	117	2.0420352	147	2.5656340	177	3.0892328
28	0.4886922	58	1.0122910	88	1.5358897	118	2.0594885	148	2.5830873	178	3.1066861
29	0.5061455	59	1.0297443	89	1.5533430	119	2.0769418	149	2.6005406	179	3.1241394
30	0.5235988	60	1.0471976	90	1.5707963	120	2.0943951	150	2.6179939	180	3.1415927

Lengths of Circular Arcs for the Radius 1

Minutes				Seconds			
0′	0 0000000	30′	0.0087266	0″	0.0000000	30″	0.0001454
1	0.0002909	31	0 0090175	1	0.0000048	31	0.0001503
2	0.0005818	32	0.0093084	2	0.0000097	32	0.0001551
3	0.0008727	33	0.0095993	3	0.0000145	33	0.0001600
4	0.0011636	34	0 0098902	4	0 0000194	34	0.0001648
5	0 0014544	35	0.0101811	5	0.0000242	35	0.0001697
6	0.0017453	36	0.0104720	6	0.0000291	36	0.0001745
7	0.0020362	37	0.0107629	7	0.0000339	37	0.0001794
8	0.0023271	38	0.0110538	8	0.0000388	38	0.0001842
9	0.0026180	39	0 0113446	9	0.0000436	39	0.0001891
10	0 0029089	40	0 0116355	10	0.0000485	40	0.0001939
11	0 0031998	41	0.0119264	11	0.0000533	41	0.0001988
12	0.0034907	42	0.0122173	12	0.0000582	42	0.0002036
13	0.0037815	43	0.0125082	13	0.0000630	43	0.0002085
14	0.0040724	44	0.0127991	14	0.0000679	44	0.0002133
15	0 0043633	45	0 0130900	15	0.0000727	45	0.0002182
16	0 0046542	46	0 0133809	16	0.0000776	46	0.0002230
17	0.0049451	47	0.0136717	17	0.0000824	47	0.0002279
18	0.0052360	48	0.0139626	18	0.0000873	48	0.0002327
19	0.0055269	49	0.0142535	19	0.0000921	49	0.0002376
20	0.0058178	50	0.0145444	20	0.0000970	50	0.0002424
21	0.0061087	51	0.0148353	21	0.0001018	51	0.0002473
22	0.0063995	52	0.0151262	22	0.0001067	52	0.0002521
23	0.0066904	53	0.0154171	23	0.0001115	53	0 0002570
24	0.0069813	54	0.0157080	24	0.0001164	54	0.0002618
25	0.0072722	55	0.0159989	25	0.0001212	55	0.0002666
26	0 0075631	56	0.0162897	26	0.0001261	56	0.0002715
27	0 0078540	57	0.0165806	27	0.0001309	57	0 0002763
28	0 0081449	58	0.0168715	28	0.0001357	58	0.0002812
29	0.0084358	59	0.0171624	29	0.0001406	59	0.0002860
30	0.0087266	60	0.0174533	30	0.0001454	60	0.0002909

Diagrams of Wheel Flanges



Determinations of Widths of Grooves of Rails

When the wheel base, radius of curve and wheel flange are given—

1st. In the table for angle *A* under the given wheel base and opposite the next smaller radius will be found the angle that the wheels make with the rails.

2d. From the full size sections of wheel flanges shown on our sheet of diagrams of wheel flanges, select one that fits the given wheel flange approximately.

3d. In the table for width of groove *D* opposite to the number of the selected wheel flange, find next larger angle than angle *A* already found. The desired width of groove *D* is at the top of the column in which this angle is found.

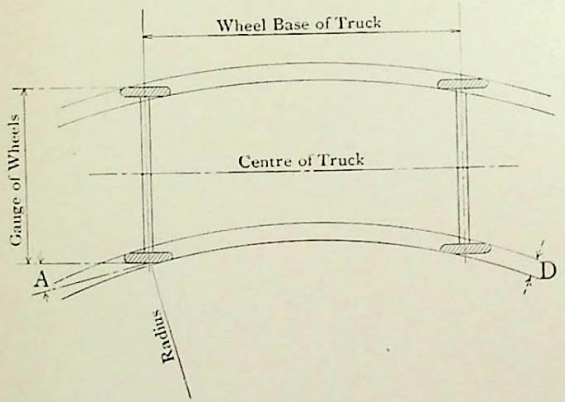
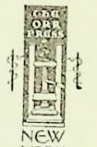


Table for Angle *A* which Wheels Make with Rails

Radii	Wheel Bases										
	4′ 0″	4′ 6″	5′ 0″	5′ 6″	6′ 0″	6′ 6″	7′ 0″	7′ 6″	8′ 0″	8′ 6″	9′ 0″
350′	0° 20′	0° 22′	0° 25′	0° 27′	0° 29′	0° 32′	0° 34′	0° 37′	0° 39′	0° 42′	0° 44′
175	0 39	0 44	0 49	0 54	0 59	1 04	1 09	1 14	1 19	1 23	1 28
120	0 57	1 04	1 12	1 19	1 26	1 33	1 40	1 47	1 55	2 02	2 09
95	1 12	1 21	1 30	1 40	1 49	1 58	2 07	2 16	2 25	2 34	2 43
75	1 32	1 43	1 55	2 06	2 18	2 29	2 40	2 52	3 03	3 15	3 26
57	2 01	2 16	2 31	2 46	3 01	3 16	3 31	3 46	4 01	4 17	4 32
45	2 33	2 52	3 11	3 30	3 49	4 08	4 28	4 47	5 06	5 25	5 44
37	3 06	3 29	3 52	4 16	4 39	5 02	5 26	5 49	6 12	6 36	6 59
33	3 28	3 55	4 21	4 47	5 13	5 39	6 05	6 31	6 58	7 24	7 50
30	3 49	4 18	4 47	5 16	5 44	6 13	6 42	7 11	7 40	8 09	8 38
27	4 15	4 47	5 19	5 51	6 23	6 55	7 27	7 59	8 31	9 03	9 36

Table for Width of Groove *D*

No. of Flange	Diam. of Wheel	Min. Width Groove	1″	1⅛″	1¼″	1⅜″	1½″	1⅝″	1¾″	1⅞″	2″	2⅛″	2¼″	2⅜″	2½″	2⅝″
1	33″	1 1/16″						1° 25′	2° 35′	3° 39′	4° 53′	5° 59′	6° 49′	7° 30′	8° 19′	9° 08′
2	33	1 5/16				0° 38′	2° 00′	3 10	4 21	5 25	6 26	7 20	8 03	8 53	9 34	10 22
3	33	1 1/4				1 28	2 52	4 05	5 11	6 06	7 00	7 52	8 41	9 32	10 18	11 01
4	33	1 3/32			2° 20′	3 45	4 59	6 08	7 05	8 04	8 48	9 40	10 33	11 22	12 09	12 57
5	33	1		1° 48′	3 10	4 22	5 28	6 30	7 29	8 25	9 24	10 30	11 23	12 17	13 00	14 07
6	33	1 1/32		1 56	3 25	4 32	5 43	6 50	7 53	8 50	9 45	10 40	11 39	12 30	13 27	14 15
7	33	0 31/32		2 19	3 34	4 40	5 41	6 43	7 38	8 41	9 30	10 27	11 21	12 14	13 03	13 56
8	33	0 15/16	2° 40′	4 17	5 28	6 37	7 43	8 46	9 47	10 44	11 47	12 51	13 51	14 52	15 54	16 49
9	33	0 3/4	3 00	4 30	5 36	6 44	7 45	8 44	9 46	10 43	11 44	12 43	13 40	14 37	15 30	16 32

BARTLETT
& COMPANY

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